

THE SOCIAL STRUCTURE OF INTERNATIONAL TELECOMMUNICATIONS

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Prepared for Sawhney, H. and Barnett, G.A. (Eds.) Progress in Communication Sciences: Advances in Telecommunication Research, volume 15, Norwood, NJ: Ablex Publishing Corporation.

September, 1996

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Introduction

With the recent advent of computer-based communication technologies, communication networks have become an important factor in global interaction. The world in the information age may be described as being connected by a lattice of networks (Mulgan, 1991). Telephones, for example, provide the basic connection for social interaction between individuals, and the linkages both within and among nations, producing what Deutsch (1953) has called "a web of nations". This is first time in history that humans beings are able to realize the prospect of communication networks which link everyone in the world (Dizard, 1989). In fact, information technologies now provide the basic infrastructure for an interdependent world, leading theorists to characterize the world as a "global village" (McLuhan, 1966).

The ongoing information revolution involving data storage, processing, transmitting and retrieval obviously affects all aspects of social, political and economic life. There are two major characteristics of the information age or post-industrial society: the information economy and transborder communication. While industrial society was based on the production of goods, the information society is built on the creation and distribution of information. The emergence of the information economy has led the expansion of the service sector as compared to the manufacturing sector. Statistics about the information economy are striking. According to Bell (1973), a total of 39.5% of the workers were in the service sectors (e.g., transport, trade, insurance, banking, public administration, personal service) in 1960s. The proportion had increased to 47.6% by 1973. Porat (1977) also described the emergence of the information economy noting that by the 1970s, near half of the U.S. work force can be classified as information workers. This trend has continued.

Frederick (1993) observed that worldwide telecommunication services during 1980s grew about 800%. UNESCO reported, "that the total world information and communication economy in 1986 was \$1,185 billion, about 8 to 9% of total world output, of which \$515 billion was in the United States" (p. 58). Information has saturated every aspect of human life including international political, economic and social relations. In other words, information is a resource of power for countries' interaction with each other on the global stage.

Globalization, the other major characteristic of the information age, is the process of strengthening the worldwide social relations which link distant localities in such a way

that local events are shaped by circumstances at other places in the world (Giddens, 1990). Thus, what happens in a local neighborhood is likely to be influenced by factors operating at an indefinite distance away from that neighborhood itself. The increase in transborder communication has led to the rapid global diffusion of values, ideas, opinions, and technologies. Transborder communication has changed our concepts of time and space (Giddens, 1990). Technologies have eliminated national boundaries and geographic separation and created a global community (Cherry, 1977; Pool, 1990; Frederick, 1993).

Giddens (1990) argues that globalization is an inherent part of modernization. One consequence of modernization is the increase in time-space distancing which makes physical distance increasingly less important in social relations. Globalization stretches the boundaries of social interaction such that the connections between different social contexts or nations become networked across the earth as a whole. This chapter describes the structure of international telecommunications. Structure refers to the stable patterns of use of the telecommunication systems by the nations of the world. The chapter then discusses the antecedent factors which have determined the relations among the members of the global community and how this structure has changed over time as the world emerges into the information age.

World Systems Theory. With the advancement of information technologies, the world can be divided into the information-rich and the information-poor countries. The global economy may be characterized by an unequal exchange between powerful information-rich and information-poor countries (Barnett, Jacobson, Choi & Sun, 1993). This gap between the haves and the have-nots in the global interaction is widening. In fact, a country's interaction patterns are associated with its levels of economic and political development (Sun & Barnett, 1994). These relations may be understood in the context of World System theory (Wallerstein, 1976; Chirot & Hall, 1982; Chase-Dunn, 1989; Knoke & Burmeister-May, 1990; Chase-Dunn & Grimes, 1995).

World System theory seeks to analyze long-term social changes by combining the study of societal level processes with the study of intersocietal relations. It challenges the assumption that nations are independent and that their development can be understood without taking into account the systematic ways in which societies are linked to one another in the context of a larger network of material and capital exchanges (Chase-Dunn, 1989).

World System theory focuses on the unequal distribution of power and goods in the capitalist world system. It argues that an identifiable social system exists beyond the boundaries of nations and states. This social system is the global economic

system. All countries are interrelated and linked in the world capitalist system and any change in an individual country is a result of events in the world system. Economic relationships within the world system are politically enforced and, as such, are relatively stable. This integration is a result of the interdependence and dynamic interaction among nation-states of uneven power (Chase-Dunn, 1992).

World System theory describes the global structure in terms of three types of structural equivalent components (nations): the core, the periphery, and the semi-periphery. In modern history, economic relationships exist among these components. Peripheral societies specialize in the production and export of labor-intensive, low-wage, low-technology goods desired by the core and the semi-periphery. In return, the core produces capital-intensive, high-wage, high-technology goods in order to export to the periphery and semi-periphery. The semi-periphery engages in both core-like activity (the exploiter), and peripheral-like activities (the exploited) in the world system (Shannon, 1989). While there is some dispute regarding the classification of specific nations as core, semi-peripheral and peripheral (Smith & White, 1992), a country's membership in one of these categories tends to be stable. Core countries stay at the center of the world's economic system and the peripheral states remain peripheral. What little change there is involves the semi-peripheral societies, as they move toward the center or periphery depending on global social, political and economic factors.

The implications of World System theory are: (1) the structural position of a country determines its potential for development and its interaction patterns; (2) the structural position of a country is a result of its interactions with other countries; (3) there are two kinds of semi-periphery nations: a) core-like nations which are developing core-like dominance in the world system; and b) periphery-like nations which are losing major dominance in the world system; and (4) the relationships among the nations in the network are relatively stable, changing only as the distribution of the modes of production change.

Traditionally, World System theory has ignored the exchange of information among the world's nations. Only recently has it been discussed in these terms (Barnett, et al., 1993; Chase-Dunn & Hall, 1994). This chapter extends the theoretical arguments from the World Systems perspective to the emerging post-industrial society. Clearly, the transition into an information based economy could serve as a catalyst to reorganize the world system provided that this transition involves changes in the modes of production and their patterns of ownership. These changes could increase competition and conflict, create new scarcities of necessary resources, result in dependencies on new types of production and the need for

collective savings and investment in long term large scale projects which would alter the structure of the global economy (Chase-Dunn & Hall, 1994).

Network Analysis

The structure of the international telecommunications may be examined through network analysis. Network analysis is a set of research procedures for identifying structures in social systems based on the relations among the system's components rather than the attributes of individual cases (Rogers & Kincaid, 1981; Wellman & Berkowitz, 1988; Richards & Barnett, 1993). The method may be generalized to describe the patterns of communication among different social systems or nation states. This chapter describes the relations among nation states and how they changed between the late 1970s through the early 1990s. The specific relation of concern is the frequency of communication among nations mediated through telecommunications; for purposes of this research, the telephone, although these procedures may be extended to other forms of telecommunication (Barnett & Rice, 1985; Danowski & Edison-Swift, 1985; Ahn & Barnett, 1995). Network analysis has in the past been used to investigate the relations among nations (Snyder & Kick, 1979; Bollen, 1983; Smith & White, 1992; Barnett, et al., 1993; Barnett & Wu, 1995; Kim & Barnett, 1996).

The basic network data set is a $n \times n$ matrix \mathbf{S} , where n equals the number of nodes in the analysis. A node is the unit of analysis. It may be an individual or higher level component, such as an organization or a nation out of which the system is composed. Each cell, s_{ij} , indicates the strength of the relationship among nodes i and j . In communication research, this relationship is generally the frequency of communication among the nodes. The frequency may be restricted to a particular topic, communication channel (the telephone) or language. For example, s_{ij} could be the frequency of communication over the telephone between i and j in German or French. \mathbf{S} is symmetrical ($s_{ij} = s_{ji}$) when one is not concerned with directionality. In those instances when the source and receiver of the information are differentiated, \mathbf{S} is asymmetrical ($s_{ij} \neq s_{ji}$). Given its form, a number of different mathematical or statistical methods may be applied to \mathbf{S} to facilitate the description of the structure of the network. In this chapter, multidimensional scaling (Woelfel & Fink, 1980; Barnett & Woelfel, 1988), correspondence analysis (Barnett, 1993), cluster analysis (Aldenderfer & Blashfield, 1984), and graph theoretic methods (Wasserman & Faust, 1994) are employed to describe the social structure of the international telecommunications network. They will be discussed in greater detail when specific research is reviewed.

The Data

International Telephone. Through out this chapter the international telecommunications network is discussed using data which describe global communications at 14 points in time, 1978 to 1992. The network is described annually with the exception of 1984. The data were gathered from two sources. The data from 1978 to 1990 were collected as part of a self-report survey by AT&T and published in The World's Telephones (AT&T, 1990). The 1991 and 1992 data were collected by the International Institute of Communications and were published in TeleGeography (Staple, 1992).

AT&T asked representatives of countries to report the most frequently called countries and the number of messages sent. Since not all respondents reported the number of messages, the analysis of the network is based only upon the most frequently called countries. The data were reported in rank order of the number of messages and were treated in this way in the analysis. The ten most frequently called countries were reported. The links were coded 10 for the most frequently called country, 9 for the second most, 8 for the third, and so on.

In the 1978 data only the three most frequent countries were reported. The number increased to five for 1979. For 1980 to 1983 only the seven most frequent countries were reported. Between 1985 and 1990 the ten most frequently called countries were reported. A somewhat different set of countries responded to the survey each year. The sample sizes ranged from 85 in 1985 to 137 in 1979. Eliminated from the analysis were Puerto Rico, The Virgin Islands, The Channel Islands and the various South African homelands. The United Kingdom did not report its frequencies of international telephone calls in the AT&T data sets. However, since the reported data were directional, it was added as a node based on its rank as a receiver of telephone messages. The final sample sizes for each data set are reported in Table 3.

The 1991 and 1992 data were compiled by the International Institute of Communications (IIC) from an independent survey of telecommunications service providers (Staple, 1992). In some cases, traffic data were estimated based upon annual reports, government publications and industry interviews. They also consulted the following publications: Yearbook of Statistics (ITU, Geneva, 1991); International Fernsprechstatistik (Siemens, Munich, 1992); The World's Telephones January 1990, (AT&T, Indianapolis, IN, 1992); and The World's Telephones January 1989 (AT&T, Indianapolis, IN, 1990).

These data are reported in MiTT--Minutes of Telecommunication Traffic. MiTT refers to paid minutes of

public voice circuit traffic including operator assisted calls. Depending upon national conditions, MiTT may include voice and non-voice (facsimile, slow speed data) traffic (Staple & Mullins, 1989).

Only 41 countries are included in TeleGeography 1992 (1991 data), including all European Common Market members. Missing are most lesser developed nations and former members of the Eastern Block. For example, South Africa is the only sample member from that continent and Hungary is the only representative from Eastern Europe. The number of links reported ranged from 8 to 20 with an average of 13.93.

In 1992, the sample was expanded to 51. Other former Eastern Block countries (Russia, Poland and Czechoslovakia) were added as were lesser developed countries from South America (Peru and Columbia) and South Asia (Sri Lanka, Bangladesh and Thailand). The number of links ranged from 10 to 25 with an average of 15.0.

In spite of the problems of variable number of links and sample size, research indicates that the data are reliable (Barnett, et al., 1993). Network indicators among 1982, 1986 and 1989 for 53 countries who reported their international calls for these three points in time correlated between .77 and .99.

The Structure of the International Telecommunication Network

Barnett, Jacobson, Choi and Sun (1993) used NEGOPY to analyze the structure of the international telephone network. NEGOPY (Richards, 1989; Rice & Richards, 1985; Richards & Rice, 1981) is a computer program for communication network analysis (Rogers & Kincaid, 1981) which examines the cohesion or links among the nodes. It provides communication role indicators (e.g., group member, isolate, attached isolate, liaison or tree node) for each node and continuous measures of the relations among the nodes including connectedness, centrality and integrativeness, as well as, overall network characteristics, such as system density.

Centrality is the mean number of links required to reach all other nodes in a group, such that the lower the mean the more central the node. Connectedness is simply defined as a node's number of links. Integrativeness is the proportion of a focal node's links that are connected to one another. Density is the actual number of links divided by the number of possible links $[n(n-1)/2]$ (for non-directional data). Each of these measures indicates the state of the system (level of globalization) at a single point in time.

Barnett, et al. (1993) found that the international telecommunication network was composed of a single group for three different points in time, 1982, 1986 and 1993. In 1982 the network included 111 group members and two countries as attached isolates (Cook Islands and Niue Islands). The 1986 network also consisted of one group of 85 members. The network in 1989 included 93 group member countries and one attached isolate (Marshall Islands). The group connectednesses (density) were .100, .166 and .133 for 1982, 1986 and 1989 respectively.

Table 1 presents the connectedness, centrality and integrativeness for each country for 1986. The results were similar for each of the three years they examined suggesting that the structure of the network is quite stable. The Western industrial nations, the United States, United Kingdom, West Germany, France, Italy and Canada, are the most central at each point in time. Switzerland is also one of the most central countries presumably due to international banking. Japan, one of the G-7 members, is somewhat less central than the other six members. Netherlands and Spain are fairly central due to links with former colonies and being members of the European Union. Two other indicators, links (connectedness) and integrativeness, also showed a very similar pattern with centrality. All western industrial nations mentioned above have higher numbers of links and lower integration values indicating that the positions of these central countries in the world system are quite consistent in every measure.

TABLE 1 ABOUT HERE

All African, Asian and Latin American countries, except the NICs and those with relatively advanced economies like Brazil and Mexico are peripheral. These countries, along with India, Taiwan, South Korea, Singapore and Turkey are semi-peripheral, between the central, core economic powers and the lesser developed countries of the peripheral. The Soviet block countries, such as Hungary, Czechoslovakia, and East Germany are also at the periphery at all three points in time. These results are consistent with World Systems Theory.

One point of discrepancy, however, is the location of the Soviet block countries. Several scholars (Snyder & Kick, 1979; Kick, 1987; Knoke & Burmeister-May, 1990; Bergesen, 1992) have argued that these socialist countries belong to the semi-periphery. While this may be the case for a variety of

transactions characteristic of the industrial world, it does not appear to be the case for telecommunication in the information age. For communication mediated by the telephone these nations are at the periphery.

The use of NEGOPY's continuous measure of centrality is consistent with recent advocates of World System Theory (Smith & White, 1992). Chase-Dunn (1989, p. 207) asserts that, "the core/periphery dimension is a continuous variable". However, this perspective is somewhat at odds with Wallerstein (1976) original formulation of the categorical nature of the world system, with discrete boundaries between the core, semi-periphery and periphery countries. This implies there are discontinuities in the world hierarchy thus suggesting a discontinuous measure of centrality. In consideration of this theoretical controversy, Barnett, et al. (1993) also examined the world telecommunication system with a blockmodeling technique to determine if could be categorized as trichotomous. The CONCOR algorithm in UCINET IV (Borgatti, Everett & Freeman, 1992) was applied to the 1986 data.

The results revealed six different groups: 1) Western industrial countries, including the United States, Belgium, France, Germany, Italy, the Netherlands, Switzerland, and the United Kingdom; 2) Eastern Europe; 3) Caribbean and Central America; 4) the Islamic nations; 5) Asian and Eastern Pacific nations, including Japan; and 6) Africa, Canada, Israel, and the remaining countries of Europe (Spain, Sweden, Poland) and Latin America. Overall, the findings of this analysis do not support the trichotomous world of World Systems theory. There is no clear-cut classification of the semi-periphery. While it may be argued that group one could be labeled as the core, some industrial countries generally classified as core nations, i.e. Japan and Canada do not belong to this group. This suggests that it may be better to conceptualize the core/periphery dimension as a continuous variable, at least when considering the international telecommunication network.

Barnett and Choi (1995) used correspondence analysis to examine the structure of the telecommunications network (Barnett, 1993). Correspondence analysis is a metric method of multidimensional scaling for categorical data, although it may be used for ordinal, interval or ratio data. The squared distances between the points in the resultant space bear a simple relationship to the original data such that the scores of two row categories are close together if their corresponding rows are more similar. It is a discrete principal components analysis or a singular value decomposition of a matrix of chi-square distances. The decomposition produces a set of coordinates from which the nodes' location in the coordinate space may be graphically represented as a map.

Correspondence analysis has a number of advantages for network analysis (Barnett, 1993). One, when matrix \mathbf{S} is asymmetrical, it allows for the simultaneous presentation of nodes both as sources (rows) and receivers (columns) in a joint space. In cases where the data are non-directional an identical set of coordinates for the rows and columns results. Two, it normalizes the network matrix, \mathbf{S} , by the square root of the row and column marginals. This operation has the effect of controlling the "size" of the nodes. Three, correspondence analysis allows for the inclusion of variables in addition to the network matrix. This facilitates the interpretation of the network's structure by indicating where in the space each of the additional variables are relative to each of the members of the network.

The results of the correspondence analysis from Barnett and Choi (1995) are presented in Figures 1 and 2. Each accounts for 14.8% of the variance in the network. Figure 1 describes the 1986 network with each country as a communication source or origin of the telephone call. Figure 2 presents the position of each country as a receiver or destination.

FIGURES 1 and 2 ABOUT HERE

Both figure may be described as star or radial structures with the United States near the origin. This is indicative of its central position in the network. The "hub" is distinct from the origin and is composed of most Western European nations. Emanating from the hub are three arms or "spokes" which appear to be composed of regional neighbors. The first is composed of Latin America, with the Central American nations at the periphery and the South American countries toward the center. The second arm is European, with the former eastern block countries at the periphery. The third spoke is composed of East Asian and the Southwestern Pacific nations at the periphery. Nearer to the hub are the Middle Eastern and South Asian countries. The English-speaking African nations are still more central. The United Kingdom is located near the base of this arm.

There are some differences between the two figures. The European cluster is much larger in the receiver network. In the source network, Spain is on the Latin American arm, while in the receiver network, it is located in the cluster of European nations. Also, the United Kingdom is much more

peripheral in the receiver network due to its absence as a source in the 1986 data.

These results indicate that the telecommunication network may be differentiated further into three regional groups--Latin America, European and Asian/Southwest Pacific, with the United States acting as a "liaison" connecting these groups. This regional differentiation will be discussed in greater detail later in the chapter. These results may also be interpreted in light of Galtung's structural theory of imperialism.

Galtung (1971) describes international relations in structural terms. He proposes four rules for defining the structure of international interaction (communication): 1) international communication is vertical between center and peripheral nations; 2) interaction between peripheral nations is missing; 3) multilateral interaction involving all three is missing; 4) interaction with the outside world is monopolized by the center. In other words, "there is interaction along the spokes, from the periphery to the center hub; but not along the rim, from periphery nation to another (Galtung, 1971, p. 97)". Indeed, as shown in Figures 1 and 2 the international telecommunications network may be described as a star or radial structure with the United States near the origin or center of the network. The hub is distinct from the origin and is composed of most of the Western European nations. Emanating from the hub are three arms or spokes which appear to be composed of regional neighbors. In other words, there is communication along the spokes but not along the rim. Communication from one peripheral nation to another must go through the center or the hub.

Barnett and Salisbury (1996) examined the telecommunications network using the 1992 data. Table 2 presents the results from NEGOPY for connectedness, centrality and integration for the individual countries. The results are similar to those reported by Barnett, et al. (1993) and Sun and Barnett (1994) except that there are only 51 nations. Missing from the data are large numbers of lesser developed countries. However, because there are fewer nodes the overall structure is easier to discern.

TABLE 2 ABOUT HERE

The results from indicated that the network is compose of a single group with the United States and the western economic powers--United Kingdom, Germany, France, Italy and Canada at the center, and the LDC's (Uruguay, Peru, Columbia, Saudi

Arabia, and Chile) at the periphery (See Table X). Japan is the least central of the core countries, perhaps due to its location in East Asia. Sri Lanka and Bangladesh are not group members. They may be classified as attached isolates with links only to the United Kingdom. The system is relatively dense (.352), with about one in three possible connections present.

NEGOPY's measure of centrality does not consider the strength of links (frequency of communication) among nodes. It accounts only for the number of links required to reach each of the other nodes in the network. An alternative is Bonacich's (1972) measure of centrality. It considers the strength of the relationships among the nodes by taking the eigenvector of the largest eigenvalue of matrix **S**, standardized so that its length is equal to the eigenvalue. The loadings on this vector indicate a node's centrality. The algorithm from UCINET IV (Borgatti, et al., 1992) was employed to determine the countries' centrality for 1992. It should be noted that this analysis was not possible for the AT&T data sets which did not measure the actual frequency of telecommunication. Instead, they only report the rank order of the most frequently called countries.

Bonacich's measure of centrality is also presented in Table 2. Worth noting are the differences between the two centrality measures. NEGOPY's results are Eurocentric in the sense that it places the UK, Germany, France, Italy, Canada, Switzerland, the Netherlands and Spain at the center directly after the United States. Bonacich's measure is centered more about the United States. Due to Canada's and Mexico's great frequency of interaction with the United States, they are ranked as the second and third most central countries in the system followed by the core European countries. Japan is more central by the Bonacich measure, moving from the thirteenth to eighth most central, supplanting Switzerland, the Netherlands and Spain. The other European nations are more peripheral, while the Latin American countries are somewhat more central.

Overall, the two centrality measures correlate .71 ($F = 48.12$, $p < .001$). Both measures correlate significantly with GDP per capita. The coefficients are: .624 ($F = 29.31$, $p < .001$) for NEGOPY and .438 ($F = 10.90$, $p < .001$) for the Bonacich measure.

Figure 3 presents the two-dimensional results of a multidimensional scaling of matrix **S** (the frequency of communication--1992) obtained from the non-euclidian metric MDS algorithm from UCINET IV (Borgatti, et al., 1992). These two dimensions account for 70.1% of the variance in the network. At the center of the figure are the United States, United Kingdom, Canada, Germany and France. Around the periphery are

Uruguay, Ireland, South Africa, Hungary, Turkey, Luxembourg, Malaysia, Philippines, Indonesia, Saudi Arabia, Columbia, Iceland, Sri Lanka and Bangladesh. These countries are relatively less economically developed than the countries at the center of the network and thus are consistent with World System theory. Worth noting is Japan's location among the peripheral Asian countries.

FIGURE 3 ABOUT HERE

Recent research with these data has examined the differences between nations' positions as sources and receivers in the network. The correlation between countries' centralities (from NEGOPY) as origins and destinations was .88. Hong Kong, China, Brazil and Israel has greatest residuals. These countries each had large discrepancies between the minutes of telephone calls sent and received. For example, Brazil called internationally 169.9 million minutes (MiTTs) but received over 330 MiTTs. Likewise, Israel received over 266 MiTTs of calls, while calling internationally only 153 MiTTs. Hong Kong called to China over 535 MiTTs, while China reciprocated with only 412 MiTTs. These differences may be due to differences in the nations' level of economic development telecommunications infrastructure or differential rates of tariffs for international telephone calls when compared to the other nations with whom they communicate.

The Structure of the International Telex Network

Ahn and Barnett (1995) examined the patterns of use of the international telex network for 1983, 1989 and 1991. They report a structure similar to the telephone network described by Barnett, et al. (1993). The telex network was composed of a single interconnected group with the United States and the other western developed countries at the center and the newly industrialized countries of Asia (Singapore, South Korea, Hong Kong and Taiwan) and regional powers such as Brazil, China and Egypt in semi-peripheral positions and less developed countries at the periphery. They also report that over time the network became sparser (less interconnected) and less centralized with the changes larger between the second and third measurements. For example, density dropped from .238 to .231 between 1983 and 1989 and to .213 by 1991. They interpret these findings as an indication of the disadoption of telex, suggesting that its communication function was replaced by facsimiles sent over telephone lines. As will be described later in this chapter, during this same period there was a great increase in the density and centralization of the telephone network.

Position in the Network and Developmental Indicators

Economic Development. Barnett, et al. (1993) found statistically significant correlations between various network indicators from NEGOPY and GNP per capita. Coeffieicents ranged from .30 to .55 for connectedness, .07 to .56 for centrality and .30 to .39 for integrativeness. In other words, there was a significant relationship between a country's network position and its level of economic development. The extreme outliers in this analysis were the United Arab Emirates, Qatar and Kuwait. These relatively wealthy countries were not well connected in the network. If these oil producing countries were eliminated from the analysis, the relationship between economic development and a country's position in the network would be higher.

In an attempt to determine the causal relationship between a country's position in the network and economic development, a nation's 1988 GNP per capita was predicted from the network indicators at prior points in time controlling for the GNP per capita in 1985 and 1980. Network position produced a significant incremental effect on GNP per capita. The number of links in 1982 was a significant predictor of GNP in 1988 when controlling for a nation's economy in 1980. These results suggest that the number of international telecommunication links have a significant incremental effect on economic development.

Other Developmental Indicators. Sun and Barnett (1994) examined the relationship between the structure of the international telecommunications network and the process of democratization. Democratization was measured as the extent to which citizens had the following political rights and civil liberties: 1)the right to vote; 2)the right to associate with and organize political parties; 3)the right to petition the government; 4)the rights of free speech, freedom of assembly and a free press. Civil rights were based on four critical rights and four subsidiary rights. The four critical rights were: 1)freedom from political censorship, 2)open public discussion, 3)the maintenance of a rule of law and 4)freedom from government terror. The subsidiary rights were: 1)economic independence of the media; 2)freedom of movement; 3)freedom of choice, including the right to choose one's religion, college, occupation, labor unions, and clubs; and 4)freedom from poverty. The nations of the world were rank ordered by the Freedom House and published in Freedom Review.

Using Barnett, et al. (1993) descriptive measures of the telecommunications network, they found strong relations between the network indicators and democratization through out the

1980s. The correlations ranged from .33 to .51 ($p < .001$) for number of links; .27 to .55 ($p < .01$) for centrality; and .27 to .45 ($p < .01$) for integrativeness. Further, the relationships between the network indicators and levels of democratization were stable. There was no time lag between the a country's position in the network and democratic development, making it difficult to infer causality.

Barnett, et al. (1993) examined the relation between a country's position in the telecommunication network and its quality of life, operationalized as an index composed of three social indicators; 1) infant mortality, 2) life expectancy and 3) rate of literacy. The correlations between network position and quality of life for 1975 and 1985 were significant ($r = .29$ to $.30$, $p < .01$). Together, these findings suggest a strong relationship between a country's position in the international telecommunication network and its social and political as well as economic development.

Antecedent Factors

Three factors which, in part, determine the usage patterns of the international telecommunications network are a nation's physical location, its culture and the state of its economy (Barnett, et al., 1993; Barnett & Choi, 1995). The relationship between economics and telecommunications was described earlier in the chapter. This section describes the role of physical location and language, the most significant cultural indicator, may play as antecedent conditions in organizing the international telecommunication network.

Telecommunication and Physical Location

Telecommunication is a space-adjusting technology. It permits instantaneous communication between people at a distance thereby making geographical space fungible. In terms of communication, all points on the earth may be considered equivalent (Gottmann, 1977). In other words, electronic communication alters the geometry of space in which interaction is taking place (Barnett, 1975; 1988b). It places people in a state which Korzenny (1978) labels electronic propinquity. According to Abler (1977, pp. 318-319):

Telecommunications (like transportation) can change the proximity of places by improving connections between them. Other things being equal, an individual will have more contacts with people close and fewer with people distant from him. Thus, any technology that makes it easier to contact people at a distance makes it possible to communicate as though

distance has been shortened. The space-adjusting technology of telephony has now been applied on such a massive scale that for some purposes the nation has become a single, highly interdependent communications network. Much the same can be said of the entire globe.

Thus, it is expected that physical distance among the countries of the world would have little impact in the organization of international telecommunications. However, telecommunication is a young network. While it may be evolving to a state of fungibility, traditional patterns of interaction based on physical proximity still persist. Several researchers (Deutsch & Isard, 1961; Merritt, 1964; Brams, 1966; Clark & Merritt, 1987) have studied the effect of spatial distance on international transaction flows and found that geographical proximity appears to be the primary ordering principle, with regional neighbors appearing together. Their tentative conclusion was that there is a high negative relationship between spatial distance and the strength of interactions.

Telecommunications and Language

There has been little empirical research describing the relationship between telecommunications and language. DeStefano (1990) indicates that she is unaware of any literature describes the role language plays in international telecommunications. Differences in language may act as a barrier to international communication. People who speak the same language might be expected to communicate more frequently with each other than those who don't. Laponce (1987, p. 183) notes that,

(t)he world's linguistic structure - which languages play what roles - shapes the habits of and facilities for communication, the mobility of individual citizens and their ability to link themselves to worldwide information systems..."

The boundaries between languages are more or less porous. Laponce (1985) suggests three types of boundaries, physical, linguistic and social. If there is a sharp physical discontinuity between two linguistic communities, it is normally easier for both to retain their distinct languages. Where they are in physical proximity, there will be some language crossing. The degree of linguistic border crossing varies inversely with the impermeability of the physical boundary. Thus, there is an interaction between language and physical distance.

The second type of boundary is linguistic. Two speech communities stemming from the same root will have a more porous boundary than two derived from different roots. The third type of boundary is social. Some languages have greater status than others. For example, English is considered the universal language of science, computing and business and French, the language of diplomacy (Stevenson, 1992). The language of the elite or former colonial nation may provide economic incentives for individuals to cross the linguistic boundaries. Telecommunications may provide the means for cross-boundary communication.

Telecommunications impacts directly on the use of indigenous languages (DeStefano, 1990). Laponce (1985) argues that the expansion of the global communications network is moving the world toward monolingualism. Due to American dominance in computer and communications hardware and software, and media programming, English has become the dominant language in the international media and computing. It has become the major international language or primary "link language" in the world today (Fishman, Cooper & Conrad, 1977). It is the instrument of access to international telecommunications (Weinstein, 1983). Further, since English has become the international language of business and science there is a great need to access the information exchanged by these systems. Indeed, it is also the language for most international banking, airline traffic and shipping, the primary non-personal uses of telecommunications. Thus, not being able to communicate in English represents a barrier to access to the international telecommunications network. As a result, people are required to learn and communicate in English in order to use telecommunications technology.

Wellman and Tindall (1993) examined the role of the telephone in the maintenance of social networks. They found that residential distance is not related to the use of the telephone. People do tend to call more often those who live further away but still within local calling areas. By contrast, they tend to make more long-distance calls to those who live comparatively close. Thus, the telephone facilitates the maintenance of spatially-dispersed networks. They simply help connect kin and friends. Personal community networks in which these friends fit are not the traditional densely-knit solidarities of neighbors. The telephone allows kin and friends to be strongly connected even when living apart. As such, the telephone facilitates language maintenance among immigrants in culturally foreign settings.

Past research suggests that language has a major influence on the structure of international telecommunications by acting

as a barrier which restricts communication. Mackay (1958) examined the use of long distance telephone traffic in Canada and found that there was a drop in traffic from cities in French-speaking Quebec (Montreal, Quebec City and Sherbrooke) to the largest English-speaking cities in Canada. Traffic was about a fifth to a tenth that of other cities in Quebec. The difference in language posed a barrier to telecommunication.

Klaassen, Wagenaar and Weg (1972) developed a model to predict telephone traffic among the various regions of Belgium. They report a language disparity between the Flemish and French speaking regions of the country. Again, differences in language act to restrict telecommunications traffic.

Yatrakis (1972) found that the more similar two countries language use, the greater their demand for telephone services between the two countries. Language similarity was operationalized as follows. A value of three was assigned to routes between two countries whose main or official language was identical. The value of two was used where a sizable portion of one country's inhabitants understand the language of the other or where large segments of both countries' populations speak a common third language. One was assigned between countries whose languages belong to the same family (Romance, Nordic, etc). A value of zero was given to all routes failing to meet these criteria.

Kellerman (1990) examined the international telecommunications network and found that a nation's most frequently telephoned countries, generally, were those who spoke the same language. For example, 1987 data for the Federal Republic of Germany indicates that its most frequently called nations were Austria, Switzerland, Italy, East Germany and The Netherlands. All these countries are either German-speaking, contain a German-speaking minority or speak a language close to German. These patterns of communication exist despite Germany's strong economic relations with Japan, France, U.S. and U.K., its leading trading partners in 1989 (World Bank, 1990).

Rossera (1990) identified discontinuities in telephone communication among regions of Switzerland with different languages. The presence of discontinuities in contacts between regions were identified easily with a plausible degree of certainty, if one compared the intensity of these interactions at the interior of regions with the same linguistic characteristics.

Telecommunication and Physical Location and Language

Barnett and Choi (1995) used two forms of multidimensional scaling (MDS) to examine the role of language and physical location in determining the structure of the telecommunications network. The first was correspondence analysis. Since, correspondence analysis allows for the inclusion of variables in addition to the network matrix to facilitate the interpretation of the network's structure by indicating where in the space each of the additional variables are relative to each of the members of the network, they added four language variables, one each for English, Spanish, French and German to the 1986 data.

The second type of multidimensional scaling used to describe the data was the Galileo System (Woelfel & Fink, 1980; Barnett & Woelfel, 1988). Galileo has been used extensively for the study of communication networks (Barnett & Rice, 1985; Rice & Barnett, 1985; Barnett, 1988a, 1988b) and linguistic processes (Barnett, 1977a, 1977b, 1988c; Barnett, et. al., 1984) and was by Barnett and Choi used to analyze the 1989 telecommunication network.

The first step in the Galileo analysis of network data is to transform matrix S from frequencies (rank order of telephone calls) to communication distances, S' . The goal of this operation is to assign the smallest value to the cell with the greatest frequency, such that the stronger the relationship between two nodes, the closer they are in space (Barnett, 1988a). This was accomplished by subtracting each cell from 10, the maximum rank. Thus, s'_{ij} represents the communication distance between two countries.

S' was converted to a multidimensional space with each country located on a series of projections on orthogonal dimensions. Mathematically, this process is equivalent to converting a matrix of intercity distances to Cartesian coordinates where latitude, longitude and altitude are the dimensions and the cities' locations on each dimension is given. From the coordinates a graphic representation, a map, may be drawn.

If the spaces produced by the network analysis were fungible all the nodes would occupy identical locations. To the extent that the countries' pattern of communication are not equivalent the spaces will be differentiated. The contributions of physical distance and language to the organization of the international telecommunication network was determined through regression analysis.

Because the coordinates from the MDS are orthogonal, they may be treated as a series of unique variables, each of which

may be considered as a separate dependent variable. Latitude and longitude and the four language variables, one each for English, Spanish, French and German, may be treated as independent variables. The analysis predicts the values on the dimensions of the network space from the four language variables and the two physical distance variables, latitude and longitude. The total contribution of the independent variables in the network may be determined simply by summing the multiple correlations and dividing by the number of dimensions. Because language and location may covary, the analysis will be performed separately for both sets of independent variables to determine their unique contributions.

The results of the correspondence analysis from Barnett and Choi (1995) presented in Figure 1. It describes the 1986 network with each country as a communication source along with the locations of the four languages.

As indicated above, the network may be described as having a star or radial structure with the United States near the origin. The "hub" is distinct from the origin and is composed of most Western European nations. Emanating from the hub are three arms or "spokes" which appear to be composed of regional neighbors. The first is composed of Latin America. The second arm is European, with the former eastern block countries at the periphery. The third spoke is composed of East Asian, the Southwestern Pacific, the Middle Eastern, South Asian countries and the English-speaking African nations. The United Kingdom is located near the base of this arm.

Examining the locations of the languages, Spanish, as one might expect, is located near the center of the Latin American arm. German is near the center of the European spoke. English is located in the third arm near the hub. French is located in the hub among the European nations. It should be noted that France's former colonies are also located in this cluster.

These results indicate that the telecommunication network may be differentiated into three regional groups--Latin America, European and Asian/Southwest Pacific, with the United States acting as a "liaison" connecting these groups. This suggests that the international telecommunications network is, in part, organized by physical location. Barnett & Choi (1995) further suggest that language does play a role in the organization of the international telephone network. All the Spanish-speaking countries are on one arm and the German are on another. The English are primarily on a third. Where there is a departure from this pattern, the differences appear to be due in part to geographical location. For example, Brazil is

located on the Latin American spoke and all the Asian countries are the third arm regardless of language.

The Galileo analysis from Barnett and Choi (1995) found that the 1989 telecommunications network could be accurately described by six independent dimensions. Due to the large number of countries in the network, it is impractical to present the coordinate values and a graphic representation of the network. Interpretation of the dimensions may be provided through regression and canonical analysis.

The regression analysis revealed that whether or not a country spoke the four languages was significantly related to the structure of the international telecommunication network. The multiple correlations accounted for up to 79.6% of the variance in a country's position on the individual dimensions. Together, 27.9% of the overall network structure was accounted for by language.

A similar analysis was conducted with latitude and longitude as the independent variables. Physical space alone accounted for 17.1% of the variance in the network. To control for the relationship between physical space and language the regression analysis was repeated with latitude and longitude and the four languages. A country's physical location and whether or not it spoke the four languages was significantly related to the structure of the international telecommunication network. The individual multiple correlations accounted for between 13.6% and 79.6% of the variance in a country's position on the dimensions. Together, 36.2% of the overall network structure was accounted for by physical location and language.

Dimension 1 differentiated the English-speaking countries from the German and French-speaking ones. Location on Dimension 1 was also predicted by longitude. Since the dimensions are ranked by the proportion of variance they explain in the network, it would be expected that the first dimension would describe English's position in the system (DeStefano, 1990). Dimensions 2 differentiated the Spanish-speaking countries from the others in the network. Dimension 3 was described by the use of German and a country's longitude. Dimension 4 differentiates the English and French countries. Location on dimension 4 was also predicted by longitude. Dimension 5 differentiates the countries by latitude, and Dimension 6 differentiates the French and German-speaking countries.

The overall relationship between the structure of the network and the four languages was examined using canonical correlation. Barnett and Choi (1995) report that physical

location and language and the dimensions describing the structure of the network are not independent ($X^2 = 281.92$, $df = 36$, $p = .000$). They report three significant canonicals accounting for 40.3% of the relationship between the two sets of variables. The first canonical, ($r^2 = .936$, $X^2 = 142.86$, $df = 25$, $p = .000$) separates the Spanish-speaking countries from the others. The second canonical, ($r^2 = .803$, $X^2 = 73.91$, $df = 16$, $p = .000$) differentiates the English from the French and German-speaking countries and accounts for a country's position in the network based on its latitude and longitude. The third canonical ($r^2 = .681$, $X^2 = 32.47$, $df = 9$, $p = .000$) differentiates the French and Spanish-speaking countries from the German and accounted for a country's position in the network based on its latitude.

There are other antecedents which may act to structure the international telecommunication network. As described earlier in the chapter this network is organized by the economic relations among the nations and level of social and economic development of the individual countries (Barnett, et al., 1993). Further, patterns of migration also seem to influence the network. For example, Greece and Italy communicate more with Canada than would be expected by language, physical proximity and economic relations alone. This may be accounted for by the large numbers of immigrants from those countries in Canada. Patterns of tourism and transportation may also influence the network structure. Choi (1993) examined the relationship between the telecommunications network and the patterns of other channels of international communications. He found similar structures among telecommunications, trade, air traffic and mail flows, suggesting that the structure of other international communications networks may influence the patterns of use of the international telecommunications.

Political relations among nations are apparent in the network. For example, Nicaragua was the most peripheral Latin American nation in the network in 1986. This was perhaps due to its strained political relations with the United States at that time. Also, the Eastern European countries seemed to form a separate cluster on the periphery of Europe which was probably due to their political relations with the more central countries in the network.

This suggests that the impact of other social, economic and political factors should be investigated along with language and physical distance. By examining their influence, a clearer picture of the determinants of the structure of international telecommunications may be obtained.

Changes in the Network Over Time

Barnett and Salisbury (1996) examined the changes in the international telecommunications network from 1978 to 1992. They report that, overall the network remained relatively stable over the period of investigation. In 1978, the network was composed of six groups with extensive connections among them. The six groups were: 1) Southwestern Pacific Islands and Australia; 2) Caribbean; 3) Western Hemisphere and the Netherlands, United Kingdom, English-speaking Africa, the Middle and India; 4) Scandinavia; 5) Europe, French-speaking Africa and Pacific Islands; and 6) East Asia. Also, the network included 18 countries which NEGOPY (Richards, 1989) identified as liaisons. There were 156 links (45% of a total of 344) among the six groups.

A year later (1979), the network coalesced into two interconnected groups, one with 120 countries and including most of the world (groups 1 through 5 from 1978) and another made up of 14 East and South Asian countries (group 6). Again, there were extensive ties (33 links) among the two groups, mainly through core countries (United States, United Kingdom, Germany, Italy and Canada). Since 1980, however, the network has consisted of a single group.

Table 3 and Figure 4 presents the density, and the average centrality and integration for each of the 14 points in time -- 1978 to 1992. While these indicators show that the network is changing, the rate of change is relatively slow.

TABLE 3 AND FIGURE 4 ABOUT HERE

Density. The results indicate that the network has been getting denser over time ranging from .042 (1978) to .352 (1992), a change of 31.0%. Annually, this amounts to an average change of only 1.5%. A linear regression of density over time was significant ($r^2 = .66$; $F = 23.48$, $p < .001$).

Centrality. The network has become more centralized. In 1978, the average mean number of links according to NEGOPY required to reach each other node was 2.46. It declined to 1.65 by 1992. A linear regression of average centrality over time was significant ($r^2 = .78$; $F = 41.25$, $p < .001$).

Integration. The network has become more highly integrated over time. The average proportion of a node's links that are interconnected has increased from .555 in 1978 to .765 between 1980 and 1991, a change of 19.7%. In 1992, it declined to .752. Annually, the average change is only 1.1%. A linear

regression of average integration over time was significant ($r^2 = .66$; $F = 23.73$, $p < .001$)

Changes in the Semi-periphery. Given current trends in the information society such as globalization, it might be expected that over this period of time the system would become denser, more tightly connected and more highly integrated. However, World System theory would predict that the relations among the nations in the international communication network would remain relatively stable over this short period of time in spite of changes in the transition into an information based economy. Indeed, what little change that might have occurred would be among the relations of those countries characterized as semi-peripheral (Chase-Dunn & Hall, 1994). During the 1980s, the semi-peripherals were the newly industrial countries (NICs) of Asia including, Korea, Taiwan, Singapore and Hong Kong, and the more highly developed nations of Latin America including, Mexico, Brazil, Venezuela and Argentina. Additionally, the former socialist countries of Eastern Europe (i.e., East Germany, Poland, Hungary, Czechoslovakia and Russia) may be classified as semi-peripheral because they are at the periphery of the capitalist world system, in spite of their relatively high level of economic development (Knoke, & Burmeister-May, 1990; Bergesen, 1992).

Throughout the 1980s, the core, semi-periphery and periphery were composed of the same members. At the center were the English-speaking countries, United States, the United Kingdom and Canada, the wealthier Western European countries, Germany, France, Italy, Switzerland, Spain and the Netherlands. At the periphery were the third world countries in the Pacific, Africa, Asia and Latin America, as well as, former Eastern-block countries. Between the these two categories were the semi-peripheral countries.

Over time, there was some movement among the semi-peripheral countries. To examine the changes in centrality of these countries, the percentiles of their rank on centrality (according to NEGOPY) were determined annually between 1980 and 1992. They were not determined for 1978 and 1979 because the network was composed of more than one group. Next, three group mean percentiles calculated, one for the newly industrial countries (NICs) of Asia (South Korea, Taiwan, Hong Kong and Singapore), another for wealthier countries of Latin America (Mexico, Venezuela, Brazil and Argentina), and a third for the former members of the Soviet block (East Germany, Poland, Hungary, Czechoslovakia and Russia [USSR]).

Barnett and Salisbury (1996) examined the centrality of groups of nations rather than those of individual countries for two reasons. First, the classification of specific countries as semi-peripheral is open to debate. Second, data were not available for all individual countries at each point in time.

For example, there are no data for East Germany after 1989 when it ceased to exist. As a result, the individual centrality rankings are somewhat unstable and the tracking of single countries difficult. By aggregating among countries the overall patterns of change become easier to observe. The changes in the centrality for these three groups are presented in Figure 5.

FIGURE 5 ABOUT HERE

Over time, the newly industrial countries of Asia became more central. In 1980, their average percentile was .568. During the middle of the decade it had dropped to between .455 and .375. By the end of the decade, it was about .20. The overall trend indicates movement from the periphery of the network toward the center ($r^2 = .47$, $a = .532$, $b = -.026$, $F = 6.21$, $p < .05$).

The Eastern European countries also became more central during this period. However, their change occurred at a later point in time. During most of the decade, they were at the periphery of the network. Between 1980 and 1989 their average percentile ranged between .973 and .828. 1989 marked the breakup of the Soviet Union. After this date, there was rapid movement toward the center of the network as these countries became integrated into the world economy. In 1990, the percentile centrality dropped to .452, and by 1992, it had reached .382. The overall trend indicates movement from the periphery of the network toward the center ($r^2 = .50$, $a = 1.08$, $b = -.038$, $F = 8.99$, $p < .05$).

The pattern for the Latin American semi-peripherals is more interesting. In the early 1980s, these countries were relatively peripheral. Their percentile centrality was .50 in 1980 and 1981. It dropped to a range between .36 and .25 between 1982 and 1988, reaching its most central level, .2, in 1989. After this date, the Latin American countries moved toward the periphery. In 1991 and 1992, their percentile centralities were .73 and .74, respectively. An examination of Figure 3 suggests that these countries' positions in the world's communication system was supplanted by the new democracies of Eastern Europe. The breakup of the Soviet Union seems to have provided the impetus to reposition the former Eastern Block toward the center of the network as they form direct links to the core countries in Western Europe. At the same time the Latin American countries were forced to the periphery as the Eastern European countries took over their location in the network.

These results suggest that as the world moves into the information age that the international telecommunications network is becoming denser, more centralized and more highly integrated, in other words, globalization is taking place. The fact that the network is becoming more centralized throughout this period indicates that an increasing amount of information is flowing through the core countries rather than being exchanged directly among the more peripheral nations. This is consistent with Galtung's (1971) structural theory of imperialism. It suggests that the benefits of the information revolution have not benefited all nations equally. The core nations are maintaining and perhaps enhancing their positions of economic power as the modes of production change from industrial to informational.

This chapter has extended the theoretical arguments from the World Systems perspective to the emerging post-industrial society. The transition into an information based economy could serve as a catalyst to reorganize the world system provided that this transition involves changes in the modes of production and their patterns of ownership. These changes could increase competition and conflict, create new scarcities of necessary resources, result in dependencies on new types of production and the need for collective savings and investment in long term large scale projects which would alter the structure of the global economy (Chase-Dunn & Hall, 1994). However, according to the results described above these changes have not occurred. The relations among the world's nations which have been described by World Systems analysis for the industrial age (Snyder & Kick, 1979; Smith & White, 1992; Bollen, 1983) are quite similar for the emerging information age (Barnett, et al., 1993). Ownership of the information technologies is by the core, primarily the United States, Western Europe and Japan. Thus, World Systems theory would argue for relative stability in the international telecommunication network.

Future Research

Future research will continue to investigate other international communication networks such as trade (Choi, 1993), news flow (Kim & Barnett, 1996), transportation (air traffic), migration, mail (Choi, 1993), student exchanges (Barnett & Wu, 1995), and tourism to examine how changes in these networks compare to and impact the changes in the telecommunication network. As data becomes accessible, this research will be extended to the international exchange of video and perhaps most importantly, to computer networks such as Internet analyzed using the nation-state as the unit of analysis. Recently, the author has begun to examine international monetary flows. Since money is exchanged

electronically over telecommunications networks its transfer may be conceptualized as information flows, equivalent in form to the data described in this chapter (Giddens, 1990). The monetary data can then be compared with trade and communication data to help resolve a number of the theoretical issues posed in this chapter.

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TABLE 1

INTERNATIONAL TELEPHONE NETWORK--1986

	links	Centrality row mean	standard distance	integration
U.S.A.	78	1.07	-4.693	.156
UNITED KINGDOM	63	1.25	-3.622	.190
GERMANY FED. REP.	53	1.37	-2.909	.230
FRANCE	52	1.38	-2.837	.225
ITALY	48	1.43	-2.552	.246
SWITZERLAND	36	1.57	-1.695	.337
NETHERLANDS	29	1.65	-1.195	.419
CANADA	29	1.65	-1.195	.268
SPAIN	27	1.68	-1.052	.410
JAPAN	22	1.74	-.695	.398
BELGIUM	19	1.77	-.481	.632
SWEDEN	17	1.80	-.338	.596
INDIA	16	1.81	-.267	.367
HONG KONG	18	1.81	-.267	.529
VENEZUELA	16	1.81	-.267	.467
AUSTRIA	16	1.81	-.267	.558
MEXICO	15	1.82	-.196	.581
PORTUGAL	15	1.82	-.196	.629
COLUMBIA	14	1.83	-.124	.560
BRAZIL	14	1.83	-.124	.462
KENYA	14	1.83	-.124	.626
SAUDI ARABIA	15	1.85	-.053	.333
SINAPORE	15	1.85	-.053	.562
THAILAND	12	1.86	.018	.621
ARGENTINA	12	1.86	.018	.697
ISRAEL	11	1.87	.090	.885
CHILE	11	1.87	.090	.709
NORWAY	11	1.87	.090	.836
DENMARK	11	1.87	.090	.909
TANZANIA	11	1.87	.090	.618
MOROCCO	11	1.87	.090	.764
INDONESIA	10	1.88	.161	.689
MONACO	10	1.88	.161	.889
LUXEMBOURG	10	1.88	.161	.956
IRELAND	10	1.88	.161	.867
SOUTH AFRICA	10	1.88	.161	.822
MALAWI	10	1.88	.161	.867
BERMUDA	10	1.88	.161	.800
SOUTH KOREA	9	1.89	.233	.667
PHILIPPINES	11	1.89	.233	.600
NEW ZEALAND	11	1.89	.233	.600
URUGUAY	9	1.89	.233	.861
EL SALVADOR	10	1.89	.233	.733
FINLAND	9	1.89	.233	1.000

ZIMBABWE	9	1.89	.233	.917
ZAMBIA	9	1.89	.233	.889
SIERRA LEONE	9	1.89	.233	.861
LIBERIA	9	1.89	.233	.972
BAHAMAS	10	1.89	.233	.806
TURKEY	8	1.90	.304	1.000
BAHRAIN	8	1.90	.304	.679
NEW CALEDONIA	8	1.90	.304	.536
FRENCH POLYNESIA	8	1.90	.304	.750
BRUNEI	10	1.90	.304	.844
PERU	9	1.90	.304	.788
PANAMA	10	1.90	.304	.800
MADAGASCAR	8	1.90	.304	.964
ETHIOPIA	8	1.90	.304	.821
MACAU	9	1.92	.375	.639
NETHERLANDS ANTILLES	9	1.92	.375	.472
MALTA	7	1.92	.375	1.000
CYPRUS	7	1.92	.375	.810
SENEGAL	7	1.92	.375	1.000
CAYMAN	7	1.92	.375	.762
IRAQ	6	1.93	.447	.800
PAPUA NEW GUINEA	8	1.93	.447	.893
NORFOLK ISLAND	8	1.93	.447	.714
HONDURAS	12	1.93	.447	.591
SUDAN	6	1.93	.447	.800
OMAN	7	1.94	.518	.810
TAIWAN	10	1.94	.518	.778
SOLOMON ISLANDS	7	1.94	.518	.905
MALAYSIA	8	1.94	.518	.821
PAKISTAN	9	1.96	.661	.472
NICARAGUA	9	1.96	.661	.722
COSTA RICA	9	1.96	.661	.833
POLAND	10	1.96	.661	.844
SURINAME	4	1.98	.732	.833
HUNGARY	9	1.98	.732	.674
DOMINICA	4	1.98	.732	1.000
QATAR	7	2.02	1.018	.762
DOMINICAN REP.	3	2.04	1.089	1.000
NIUE ISLAND	2	2.05	1.161	1.000
CZECHOSLOVAKIA	8	2.14	1.732	.893
GERMANY DEM. REP.	8	2.15	1.803	.857

N = 85

group col mean = 1.85 standard deviation = .167

total links = 591 Possible Links = 7140 (850)

Group Density or Connectedness = .083

TABLE 2

INTERNATIONAL TELECOMMUNICATIONS NETWORK -- 1992

	links	row mean	centality standard distance	Bonacich eigen	integration
United States	48	1.00	-3.116	95.53	.324
United Kingdom	44	1.08	-2.716	34.67	.367
Germany	40	1.17	-2.315	30.61	.400
France	37	1.23	-2.014	17.98	.417
Italy	36	1.25	-1.914	18.54	.430
Canada	31	1.35	-1.413	73.93	.439
Switzerland	25	1.48	-.812	11.31	.657
Netherlands	24	1.50	-.712	9.19	.656
Spain	23	1.52	-.611	7.73	.553
Australia	22	1.54	-.511	6.08	.563
Sweden	22	1.54	-.511	3.89	.723
Belgium	22	1.54	-.511	5.64	.710
Japan	21	1.56	-.411	14.28	.614
Denmark	18	1.63	-.110	2.48	.791
Norway	17	1.65	-.010	3.89	.809
Taiwan (ROC)	16	1.67	.090	6.03	.792
Singapore	16	1.67	.090	1.95	.767
Hong Kong	16	1.67	.090	6.78	.758
Austria	16	1.67	.090	5.10	.892
Portugal	16	1.67	.090	2.38	.758
Turkey	15	1.69	.190	4.23	.819
Russia	15	1.69	.190	1.14	.771
Poland	15	1.69	.190	2.38	.905
China	14	1.71	.290	3.03	.857
Hungary	14	1.71	.290	1.27	.857
Czechoslovakia	14	1.71	.290	1.66	.934
Thailand	13	1.73	.391	1.24	.872
South Korea	13	1.73	.391	7.70	.872
India	13	1.73	.391	4.34	.769
Greece	13	1.73	.391	2.67	.872
Brazil	13	1.73	.391	5.18	.603
Malaysia	12	1.75	.491	0.90	.879
Indonesia	12	1.75	.491	0.75	.803
Israel	12	1.75	.491	4.97	.818
Finland	12	1.75	.491	1.03	.939
Mexico	12	1.75	.491	41.30	.788
Argentina	12	1.75	.491	1.18	.636
Philippines	11	1.77	.591	7.46	.782
Luxembourg	11	1.77	.591	1.04	1.000
Ireland	11	1.77	.591	3.76	.873
Venezuela	10	1.79	.691	2.63	.733
New Zealand	9	1.81	.791	1.02	.944
South Africa	9	1.81	.791	1.35	.917
Peru	7	1.85	.992	2.73	.667
Columbia	7	1.85	.992	5.67	.905

Saudi Arabia	6	1.88	1.092	1.35	.733
Iceland	5	1.90	1.192	0.26	1.000
Chile	5	1.90	1.192	0.58	.900
Uruguay	3	1.94	1.393	0.08	1.000
mean	16.9	1.65		9.14	.752
s.d.		.208		17.57	

n = 49 (Sri Lanka and Bangladesh are isolates)

total links = 828

TABLE 3

International Telecommunication Network 1978-1992

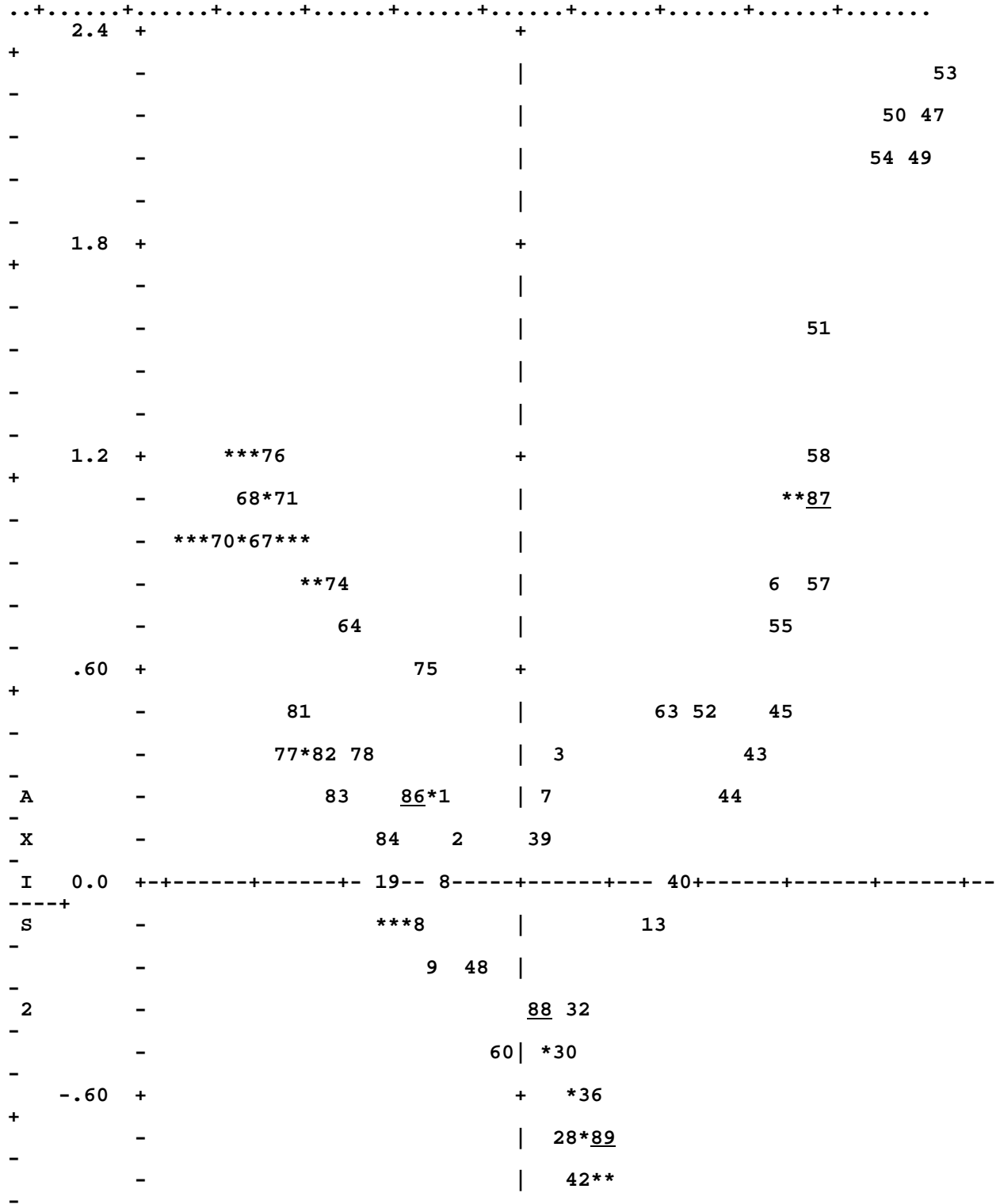
Date	Integration		N	
	Centrality	Density		
1978 ¹	2.46	.555	.042	126
1979 ²	2.21	.594	.060	137
1980	2.15	.613	.073	107
1981	2.06	.672	.100	101
1982	2.02	.630	.092	111
1983	2.08	.670	.094	107
1985	1.84	.710	.173	83
1986	1.85	.700	.166	86
1987	1.91	.617	.140	102
1988	1.91	.674	.127	97
1989	1.92	.705	.133	93
1990	1.88	.674	.144	78
1991	1.83	.765	.211	41
1992	1.65	.752	.352	51
r ²	.775	.664	.662	
F	41.25	23.75	23.48	
a	2.30	.579	.023	
b	-0.042	0.011	0.015	

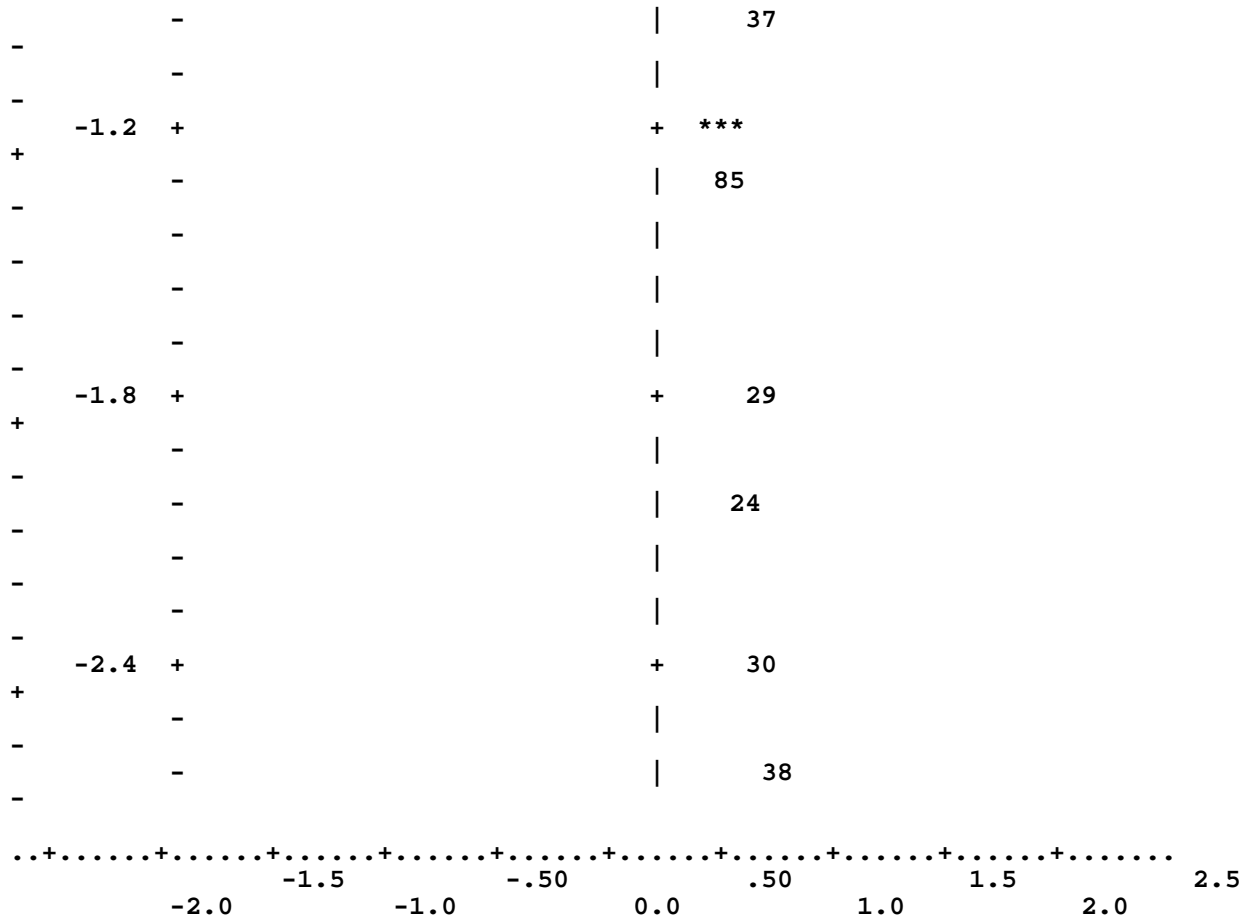
Data Source: 1978-1990 AT&T, The World's Telephones
1991, 1992 IIC, TeleGeography 1992, 1993

1. 1978 was composed of 6 groups.
2. 1979 was composed of 2 groups.

FIGURE 1
INTERNATIONAL TELECOMMUNICATIONS NETWORK WITH FOUR LANGUAGES

SOURCE NETWORK





AXIS 1
 * more than one country at this location

KEY TO FIGURES 1 AND 2

01 BAHAMAS	44 BRAZIL
02 BERMUDA	45 CHILE
03 CANADA	46 COLUMBIA
04 CAYMAN ISLANDS	47 COSTA RICA
05 DOMINICA	48 UNITED KINGDOM
06 DOMINICAN REPUBLIC	49 EL SALVADOR
07 U.S.A.	50 HONDURAS
08 ETHIOPIA	51 MEXICO
09 KENYA	52 NETHERLANDS ANTILLES
10 LIBERIA	53 NICARAGUA
11 MADAGASCAR	54 PANAMA
12 MALAWI	55 PERU
13 MOROCCO	56 SURINAME
14 SENEGAL	57 URUGUAY
15 SIERRA LEONE	58 VENEZUELA
16 SOUTH AFRICA	59 BRUNEI
17 SUDAN	60 FRENCH POLYNESIA
18 TANZANIA	61 INDONESIA
19 ZAMBIA	62 MALAYSIA
20 ZIMBABWE	63 NEW CALEDONIA
21 AUSTRIA	64 NEW ZEALAND
22 BELGIUM	65 NIUE ISLAND
23 CYPRUS	66 NORFOLK ISLAND
24 CZECHOSLOVAKIA	67 PAPUA NEW GUINEA
25 DENMARK	68 PHILIPPINES
26 FINLAND	69 SINGAPORE
27 FRANCE	70 SOLOMON ISLANDS
28 GERMANY (WEST)	71 THAILAND
29 GERMANY (EAST)	72 TAIWAN
30 HUNGARY	73 HONG KONG
31 IRELAND	74 JAPAN
32 ITALY	75 SOUTH KOREA
33 LUXEMBOURG	76 MACAU
34 MALTA	77 BAHRAIN
35 MONACO	78 INDIA
36 NETHERLANDS	79 IRAQ
37 NORWAY	80 ISRAEL
38 POLAND	81 OMAN
39 PORTUGAL	82 PAKISTAN
40 SPAIN	83 QATAR
41 SWEDEN	84 SAUDI ARABIA
42 SWITZERLAND	85 TURKEY
43 ARGENTINA	
	86 ENGLISH
	87 SPANISH
	88 FRENCH
	89 GERMAN

FIGURE 3
 INTERNATIONAL TELECOMMUNICATIONS NETWORK 1992
 METRIC MULTIDIMENSIONAL SCALING

