Telecommunication Technologies: Use and Investment Patterns in U.S. Multinational Corporations

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Telecommunication technology enables multinational corporations (MNCs) to efficiently transfer the information necessary for coordinating global operations and remaining internationally competitive. However, few published studies have empirically examined the relationship between the organizational characteristics of MNCs and their use of telecommunication technologies. This study investigated whether use of, and investment in, telecommunication technologies by MNCs is related to firm and industry characteristics.

Results from 105 U.S. MNCs reveal that the use of certain telecommunication technologies like teleconferencing networks and messaging systems differ significantly across firms with different degrees of international involvement and size; and, to a limited extent on industry characteristics. However, other technologies like inter-organizational systems and transmission media do not differ based on these characteristics. Moreover, the relative investment in such technologies as a whole differs in terms of a firm’s degree of international involvement and its industry type, but not in terms of its size. Reasons for these differences are explored. The study also highlights the growing importance of building information platforms for integrating organizational systems using a wide variety of computing and communication technologies. Implications for IS/telecommunication executives and researchers are discussed.

In their bid to compete effectively in today’s global environment, many American multinational corporations (MNCs) are implementing global telecommunication networks linking their worldwide operations together. Quick and ready access to information is vital for coordinating global operations and maintaining flexibility (Chismar, 1994). Business analysts have suggested that the long term survival of MNCs in the international marketplace may be closely tied to their ability to communicate quickly and efficiently (Deans and Karwan, 1994). In an insightful analysis, Keen (1988) predicted that:

*The ability of a multinational corporation to manage complexity and volatility will depend almost entirely on its telecommunications architecture. (p. 266)*

Other information systems researchers (e.g., Steinbart and Nath, 1992) and practitioners (e.g., Hopper, 1990) have also recognized the importance of modern telecommunication technologies for enabling MNCs to efficiently transfer information worldwide.

MNCs, relative to purely domestic firms, face more complexities due to greater geographic dispersion, more intense global competition, existence of tariff- and non-tariff trade barriers, higher cultural diversity, and a multitude of political climates (Alavi and Young, 1992; Ohmae, 1989). In dealing with such complexity, MNCs need to move away from rigid, single dimensional strategies towards more flexible, multi-dimensional strategies (Keen, 1992; Bartlett and Ghoshal, 1987). Results based on the responses of 250 managers from some of the world’s largest firms suggest that MNCs, in moving toward multi-dimensional strategies, are faced with the task of optimizing efficiency, responsiveness and learning simultaneously in their worldwide operations (Bartlett and Ghoshal, 1987). There is growing evidence that telecommunication technologies can enable MNCs to achieve such integrated, multi-dimensional strategies effectively and efficiently (Steinbart and Nath, 1992).

The fact that multinational corporations differ from purely domestic firms—in strategy and structure—creates
unique demands on international communication and computing technologies (Senn, 1994; Ives and Jarvenpaa, 1990; Iyer and Schkade, 1987). In addition to helping MNCs achieve multi-dimensional strategies, telecommunication technologies can also impact their global structure by providing simultaneous centralization and decentralization (Keen, 1992). Economic studies of the demand for international telecommunications have shown a clear relationship between demand and levels of international trade (e.g., Rea and Lage, 1978; Vernon, 1977) and the activities of multinational firms (Antonelli, 1985). These and other studies indicate that firms most likely to succeed in today’s highly competitive international environment are those MNCs that have taken the lead in adopting communication technologies and have integrated them with their corporate strategy and structure.

While literature exists on technical aspects of global telecommunications (e.g., Sankar and Prabhakar, 1992), few published studies have empirically examined the use of telecommunication technologies by U.S. MNCs. As a result, managers of MNCs find little direction from the research literature to aid them in understanding the role of telecommunications in transacting global business. Our study aims to fill this apparent gap in the literature. The results of this study will provide insight into telecommunication use, a factor considered critical for achieving global competitive advantage. The results will also enable managers to make broad comparisons of technology use and investment patterns based on organizational characteristics like firm size, level of international involvement and type of industry. Such comparisons can, when used appropriately, provide a basis for the re-evaluation of existing telecommunication strategies.

The purpose of this study is to investigate relationships between the characteristics of MNCs and their use of telecommunication technologies. The use of telecommunication technologies represents a broad concept, referring to a number of possible factors like the types of technologies used, the amount of time the technologies are used, the volume of communications across the technologies, the investment in the technologies, and the capacity and relative sophistication of the telecommunications infrastructure. Data on time and volume of usage are extremely difficult, if not impossible, to obtain for a large sample of firms. Also, usage capacity and relative technological sophistication more accurately reflect the firms’ potential for use rather than actual use. Therefore, in this study, we focus on two aspects of use: the types of technologies used and the investment into the technologies.

Section 2 provides some background on the research issues, including a brief review of the relevant literature and the hypotheses tested. The next two sections describe the research framework and methodology. Then, results of the data analysis are presented and their implications for research and practice discussed. Finally, the last section reviews the major findings from the study and provides some directions for future research.

### Background and Hypotheses

This paper is part of an ongoing study of telecommunications management in U.S. multinational corporations. Results from other aspects of this study are available elsewhere (Chidambaram and Chismar, 1993; Chismar and Chidambaram, 1992). The first article—involving interviews with executives from 27 MNCs—focused on the key challenges faced by telecom executives in managing global networks while the second article examined the effect of telecommunications on the structuring of multinational corporations. In this current paper we delve further into the relationships between organizational characteristics and the use of telecommunication technologies.

A synthesis of the literature, presented below, suggests that an MNC’s degree of international involvement, its size, and the type of industry it operates in affect its need for coordination and communication. Several authors (see for example, Roche, 1992; Ghoshal and Bartlett, 1990) posit that firms with different levels of international business, of different sizes and in different industries have, by definition, different levels of complexity and different coordination needs. This implies that MNCs with differing needs for coordination and communication will use different telecommunication technologies and invest in such technologies at different rates. Specifically, in this study we are primarily interested in this question:

**What, if any, is the relationship between the use of, and investment in telecommunication technologies by U.S. MNCs and their organizational and industry characteristics?**

While our previous efforts—examining how telecommunication influences corporate structure and what the key challenges are in managing global networks—were empirical, they were primarily exploratory and hence did not involve hypotheses development or testing. However, based on our previous findings and recent research in the area (see for example, Steinbart and Nath, 1992) we developed a set of hypotheses that were tested in this study. The discussion below elaborates on these hypotheses.

### Degree of International Involvement

In implementing global strategies, multinational corporations face complex and dynamic coordination problems (Senn, 1994; Egelhoff, 1991; Bartlett and Ghoshal, 1987). A major contributing factor to these problems is the firm’s degree of international involvement. Coordination problems increase with greater geographic and temporal dispersion of personnel, resources and activities. Hence, MNCs, relative to purely domestic firms, face greater complexities due to the greater geographic dispersion and the more intense competition. And, the greater the degree of international involvement,
the greater the complexity and need for communication and coordination (Chismar, 1994; Hopper, 1990; Ives and Jarvenpaa, 1990).

Many authors have suggested that telecommunication technologies can help MNCs deal with these coordination problems and successfully implement their strategies. For instance, Ives and Jarvenpaa (1991) highlight the importance of telecommunications in implementing global business strategies. Several researchers, including Chismar (1994) and Iyer and Schkade (1987), also agree that the geographic dispersion of international business activities requires a high level of coordination and integration, and telecommunication technologies make that possible. Thus, firms with a significant amount of international involvement would have an increased need for telecommunication technologies to communicate with their subsidiaries and coordinate their activities worldwide.

Deans et al. (1991) found that a firm’s level of international involvement significantly influenced management’s perception of the importance of information technology. This difference across firms based on the degree of international involvement is likely to extend to decisions about the type of technologies used by firms. Therefore, firms with differing degrees of international involvement will, by definition, have differing needs for communication technologies. Hence, our first organizational characteristic that was expected to distinguish the use of telecommunication technologies was a firm’s degree of international involvement. The following hypothesis reflects the synthesis of our discussion:

**Hypothesis 1: The types of telecommunication technologies used by an MNC and its investment in these technologies are related to its degree of international involvement.**

**Firm Size**

Among the earliest studies that empirically examined international issues faced by information systems executives were surveys by Selig (1982) and a case study by Knetel (1980). Selig’s work suggested that a growing number of MNCs were using information technologies, including telecommunication technology, as critical tools in monitoring and managing their global business. Based on data from 25 large MNCs, he pointed out the importance of numerous organizational issues in planning for global information systems, like the degree of decentralization, firm size, proliferation of vendors and diversity of technology offerings. Knetel’s (1980) case study also suggested the growing and changing information needs of global managers with corresponding increases in a firm’s size dimension: e.g., more product lines meant increased need for coordination and communication.

Other studies have shown that an important organizational characteristic that affects an MNC’s ability to coordinate its activities and maintain communication links with subsidiaries is firm size (Alavi and Young, 1992; Torkzadeh, 1992; Deans et al., 1991). Using data from 40 MNCs in the U.S., Italy, U.K, Germany and Sweden, Antonelli (1985) found that larger firms tended to adopt technology faster than smaller firms. (And interestingly, U.S. firms tended to adopt technology faster than their European counterparts.) There is also some evidence, and plenty of conjecture, in the telecommunication trade literature that large firms can, and do, invest in more expensive telecommunication technologies (for e.g., video-teleconferencing) than do small firms. While the observation that larger firms will invest proportionately more in telecommunications than smaller firms may seem obvious, no published study has empirically tested its veracity.

In this study, therefore, we test the expectations that (a) firm size will affect the need for coordination, and presumably, use of various communication technologies, and (b) a firm’s size will influence its level of investment in such technologies. Hence, our second hypothesis of interest is:

**Hypothesis 2: The types of telecommunication technologies used by an MNC and its investment in these technologies are related to its size.**

**Type of Industry**

Porter and Millar (1985) point out differences in information intensity among industries:

> Although a trend toward information intensity in companies and products is evident, the role and importance of the technology differs in each industry.

> Banking and insurance, for example, have always been information intensive ... On the other hand, physical processing will continue to dominate in industries that produce, say, cement, despite increased information processing in such businesses. (p. 154)

In Deans et al.’s study (1991) of 183 firms, perceptions of international information technology issues were influenced, among other factors, by a firm’s industry type (for e.g., service vs. manufacturing). Other studies (for instance, Steinbart and Nath, 1992) also suggest differences in technology use and investment by industry type.

Keen (1988) proposes that an industry in which an MNC is operating in places unique demands on the firm’s need for instant information and effective communication. The differing needs for coordination and communication imposed by different organizational and industry factors (Karimi and Kosynski, 1991) also implies that the technologies used to achieve corporate objectives would, in general, be different. This then suggests that the use of, and perhaps investment in, communication technologies can be expected to differ across industries.
Despite some evidence that industry type can result in the use of different communication technologies, there is little agreement on the nature of these differences. For instance, in the Steinbart and Nath (1992) study, manufacturing firms were more likely to have and use global networks. By contrast, the Business Week Special Report (1988), emphasized the importance of global networks for service industries. The report argues that in an integrated, international financial and trading environment, instantaneous communications are vital for a service firm’s continued success. Global networks enable these firms to reduce costs and ‘act nimbly’, i.e., respond quickly to environmental changes. Manufacturing firms, however, are more likely to use their networks for internal purposes (Steinbart and Nath, 1992). Additional research is needed to understand, and perhaps resolve, these differences.

Conventional wisdom suggests that firms in service industries are much more “information intensive” than those in manufacturing, and thus have a greater demand for and use of IT (Baker and Aggarwal, 1994; Mookerji and Cash, 1986); empirical evidence, however, has been mixed. In this study, we investigate this issue further. Our third hypothesis summarizes the above discussion:

**The types of telecommunication technologies used by an MNC and its investment in these technologies are related to the industry it operates in.**

### Research Methodology

#### Survey Development

A survey of telecommunications usage was developed based on a review of the practitioner and academic information systems and telecommunication literature dealing with global information systems issues (for example, Deans et al., 1991; Ives and Jarvenpaa, 1990; Business Week Special Report, 1988; Keen, 1988; Wigg in, 1987; Scherr, 1983). This instrument was initially reviewed by three researchers in information systems and international business. Based on their feedback, the survey instrument was modified. It was then pre-tested using senior telecommunications executives from three firms and revised to include their comments. In the next round, the instrument was reviewed by three more researchers in information systems, management, and international business at reputed universities. Their feedback was also incorporated into the final version of the survey. Hence, the instrument was subjected to a rigorous process of pre-testing and validation that lasted well over nine months.

The survey contained a total of 45 questions divided into five sections: company characteristics, telecommunications infrastructure, telecommunications management, telecommunications regulation and additional comments. A majority of the questions were based on a five-point Likert-type scale; a few open-ended and yes/no questions were also included in the survey. If respondents were not sure of the answer to a particular question, they were encouraged to provide a “best guess” estimate.

#### Sample of Firms

A sample consisting of the top 500 U.S. firms based on the ratio of their foreign sales to total sales was selected from the COMPUSTAT electronic database. This sample was augmented with 32 Fortune 500 companies for which foreign sales data were missing from the database. Surveys were mailed to the president of each firm with a cover letter requesting that the survey be forwarded to the senior telecommunications executive. The cover letter also emphasized the fact that neither the names of companies, nor the names of executives would be revealed in any reports; only aggregate data would be used in all publications. Executives who returned the completed survey were promised and received results of the data analysis.

Of the 532 surveys mailed, a total of 111 completed surveys were returned. Fifty-six completed surveys were returned on the first mailing. After seven weeks, we conducted a second mailing to those firms that did not respond to the previous mailing. The second round yielded another 55 completed surveys. Of the 111 completed surveys, a 21% response rate, 6 were eliminated due to limited international operations or incomplete responses. The analysis in this paper is based on the remaining 105 firms. The final effective response rate of 20% was on par with the response rates in similar studies (e.g., Igbaria, Parasuraman and Badawy, 1994).

### Research Framework

#### Independent Variables

As discussed earlier, a review of the literature identified three important firm and industry characteristics: degree of international involvement, firm size, and type of industry. Each of these independent variables (and the interactions among them) was expected to affect the types of telecommunication technologies used by MNCs and their levels of investment in such technologies. The discussion below describes how these variables were operationalized in our study.

**Degree of International Involvement.** The degree of international involvement represents the extent to which an MNC operates outside its home country. We used several variables to measure this construct:

- the percentage of revenue generated outside the home country (i.e., the U.S.),
- the percentage of employees outside the U.S.,
- the percentage of assets outside the U.S.,
- the percentage of manufacturing done outside the U.S., and
- the number of geographic regions in which the firm operated.

For each of the four percentage variables, respondents in
our survey were asked to select one of the following five categories of international involvement:

- 10% or less,
- 11% to 20%,
- 21% to 30%,
- 31% to 50%, and
- 51% or more.

For the geographic region variable, respondents were asked to identify all regions they operated in, from ten pre-specified regions. The survey responses showed a high degree of correlation among all of the above variables. Based on previous studies (for e.g., Deans et al., 1991) and the high degree of correlation among the variables, only the percentage of revenues generated outside the U.S. was used to evaluate the degree of a firm’s international involvement.

**Firm Size.** Firm size was measured using annual revenues—again, an approach used in previous studies (see for instance, Deans et al., 1991). Data obtained from the survey were cross-referenced with several independent sources including COMPSTAT, Compact Disclosure, and Value-Line databases. At least two sources had to corroborate, before the data was accepted as valid from the survey.

**Industry Type.** For industry type, respondents were asked to provide the percentage of their firm’s business in each of 15 pre-specified industries. To test our hypotheses that technology use and investment differ across industries, we needed a reasonable aggregation of the 15 industries. Previous studies (e.g., Deans et al., 1991) used a dichotomous classification scheme of services and manufacturing. We refined this scheme to more accurately reflect the information intensity of firm groupings in our sample; our resulting classification had three categories: heavy manufacturing, light manufacturing and service industries. Heavy manufacturing included those firms with a combined representation of 40% or more in industrial/automotive, metal/metal products, petroleum/petrochemicals and process industries. Light manufacturing included those firms with a combined representation of 40% or more in electronics, food and beverage, health care/pharmaceutical and other manufacturing industries. Finally, services included those firms with a combined representation of 40% or more in banking and finance, insurance, retail, transportation, utilities, wholesale and other service industries.

### Dependent Variables

As mentioned in the previous section, two dependent variables—type of telecommunication technology used and the relative investment into such technologies—were the focus of this study.

**Types of Telecommunication Technology Used.** The first variable, type of telecommunication technology used, represents a broad concept and includes a wide variety of technologies. In this study, four groups of technologies (each comprised of specific applications) were examined1, including:

- Teleconferencing networks for: video-conferencing and audio-conferencing;
- International messaging systems: voice messaging systems and electronic mail;
- Inter-organizational systems: electronic data interchange with customers and/or vendors;
- International transmission media including: dedicated foreign exchange lines, leased lines for data transmission, packet switching systems for data transmission, digital lines, fiber optic cables, and VSATs.

The first three groups represent different types of global telecommunication applications, while the last group represents specific transmission network technologies (Sankar and Prabhakar, 1992). Each group is discussed below.

#### a) Teleconferencing Networks:

This category of technologies includes audio- and video-conferencing networks. Such technologies have gained wide acceptance in the last decade and continue to increase in popularity (Keen, 1992; Roche, 1991). They offer a cheaper and more efficient alternative to international travel, and can improve the speed of decision making. As argued earlier, we expected the use of such networks to differ based on a firm’s level of international involvement, size and type of industry.

#### b) International Messaging Systems:

This group of technologies, unlike the previous one, offers asynchronous communication capabilities to users on a global scale. The two technologies included in our survey were electronic mail and voice mail. While voice mail (for international communication) is relatively recent in its origins, e-mail has a longer history. It offers a low-cost and efficient means of communicating globally, and some firms are increasingly using e-mail as the primary means of internal communication (Business Week Special Report, 1988). As argued earlier, it was expected that organizational and industry characteristics would affect the use of messaging systems like e-mail and voice-mail for international communication.

#### c) Inter-organizational Systems:

A lot has been written about inter-organizational systems in the academic and the practitioner press (for e.g., Steinbart and Nath, 1992; Roche, 1991; Pantages, 1989). A primary implementation of such systems is in the form of electronic document interchanges (EDI), where data in standard business documents are electronically transmitted to suppliers (outbound EDI) and/or customers (inbound EDI). Such a system, besides automating routine business transac-
tions and thereby eliminating “paper”, can also provide an important strategic advantage to participating firms (Roche, 1992). As with other technologies, use of international EDI was expected to differ based on a firm’s degree of international involvement, size and industry.

**d) International Transmission Media:**

Technologies included in this category were dedicated foreign exchange (FX) lines for international voice transmission, leased lines and packet switching exchanges for international data transmission, digital lines, fiber optic cables and very small aperture terminals (VSATs). These technologies represent a variety of transmission media and were expected to differ in their level of usage based on organizational and industry characteristics.

**Relative Investment in Telecommunications.** The second dependent variable of interest in our research framework was relative investment in telecommunications. Investment in telecommunication technologies has been growing rapidly for the last few years (Keen, 1992; Hall and McCauley, 1987). Total sales of equipment and transmission lines in the U.S. grew from $13.2 billion in 1986 to $15.1 billion in 1988, a growth of over 14%, according to the Gartner Group, a private research firm. In the Business Week Special Report referred to earlier, the consulting firm of Booz, Allen and Hamilton estimated that the business of moving electronic information grew from $390 billion in 1987 to $560 billion by the end of 1991.

Based on previous studies (for instance, Torkzadeh, 1992), the total annual budget for telecommunications was used to derive investment in telecommunications. The budget values were reported by the senior telecommunication managers and included depreciation of equipment, charges for leased equipment and services, expenditures for personnel etc. To obtain a normalized measure across firm size, this variable was measured as a percentage of the firm’s revenue, yielding relative investment in telecommunications.

**Summary of Hypotheses Tested**

Based on the breakdown of the first dependent variable—type of telecommunication technology used—into four specific categories: teleconferencing networks, international messaging systems, inter-organizational systems, and transmission media, and the second dependent variable—relative investment in telecommunication technology—the original three hypotheses presented earlier were extended to fifteen sub-hypotheses. The first 12 sub-hypotheses relate degree of international involvement, firm size and industry type to each of the four technology categories, while the last three relate the same variables to relative investment in telecommunication technology. Table 1 parsimoniously presents the complete set of fifteen hypotheses.

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### Hypotheses related to the Types of Telecommunication Technologies Used

**H1: The type of telecommunication technology used by an MNC is related to its degree of international involvement.**

- **H1a:** The use of teleconferencing networks by an MNC is related to its degree of international involvement. (1)
- **H1b:** The use of messaging systems by an MNC is related to its degree of international involvement. (2)
- **H1c:** The use of interorganizational systems by an MNC is related to its degree of international involvement. (3)
- **H1d:** The use of transmission media by an MNC is related to its degree of international involvement. (4)

**H2: The type of telecommunication technology used by an MNC is related to its size.**

- **H2a:** The use of teleconferencing networks by an MNC is related to its size. (5)
- **H2b:** The use of messaging systems by an MNC is related to its size. (6)
- **H2c:** The use of interorganizational systems by an MNC is related to its size. (7)
- **H2d:** The use of transmission media by an MNC is related to its size. (8)

**H3: The type of telecommunication technology used by an MNC is related to the industry it is in.**

- **H3a:** The use of teleconferencing networks by an MNC is related to the industry it is in. (9)
- **H3b:** The use of messaging systems by an MNC is related to the industry it is in. (10)
- **H3c:** The use of interorganizational systems by an MNC is related to the industry it is in. (11)
- **H3d:** The use of transmission media by an MNC is related to the industry it is in. (12)

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### Hypotheses related to Relative Investment in Telecommunication Technologies

**H4: The relative investment in telecommunication technologies made by an MNC is related to its degree of international involvement.**

- **H4a:** The relative investment in telecommunication technologies made by an MNC is related to its degree of international involvement. (13)

**H5: The relative investment in telecommunication technologies made by an MNC is related to its size.**

- **H5a:** The relative investment in telecommunication technologies made by an MNC is related to its size. (14)

**H6: The relative investment in telecommunication technologies made by an MNC is related to the industry it is in.**

- **H6a:** The relative investment in telecommunication technologies made by an MNC is related to the industry it is in. (15)

*(sub-hypothesis number in parenthesis)*

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### Table 1: Complete Set of Hypotheses Tested Results and Discussion

**Characteristics of Respondent Firms**

The 105 firms in our sample were fairly large, U.S. multinationals with revenues ranging from approximately $270 million to $60 billion with mean revenues of $5.25 billion. To facilitate the analysis, the firms were classified post-hoc into the following five categories based on revenues (the figures in parenthesis denote number of firms in each category):

- Less than $500 million (16),
- Over $500 million and less than $2 billion (27),
- Over $2 billion and less than $5 billion (25),
- Over $5 billion and less than $10 billion (20), and
- Over $10 billion (17).
The firms had widely dispersed operations; of the ten geographic regions specified in the survey, they had operations in an average of 6 regions. (See Figure 1 for a detailed breakdown by geographic region.) Averaging over 20 percent of their revenues from overseas operations, the firms were well dispersed across the survey’s five different classifications of international business:

- Less than 10% of revenues from overseas (29),
- 11% to 20% of revenues from overseas (25),
- 21% to 30% of revenues from overseas (12),
- 31% to 50% of revenues from overseas (28), and
- Greater than 50% of revenues from overseas (11).

Also, the firms were dispersed over a wide range of industries with 30 firms in the service sector, 39 in light manufacturing, and 36 in heavy manufacturing.

Figure 2 summarizes the use of individual technologies for the entire sample. For their international telecommunication transmissions, the firms averaged 68% voice, 31% data,
and 1% video; 64% of these transmissions were analog and 36% were digital. Figures 3, 4, and 5, respectively, show use of the technologies by degree of international involvement, firm size, and industry type.

**Hypotheses related to Type of Telecommunications Technology Used**

As mentioned earlier, the 12 individual telecommunication technologies were divided into four groups:

- teleconferencing networks,
- international messaging systems,
- inter-organizational systems, and
- transmission media.

Results for each group of technologies are discussed below. A three-way factorial MANOVA with 3 independent variables (degree of international involvement, firm size and industry type) and four sets of dependent variables (the four categories of technologies listed above) was used for testing the hypotheses. Within this model, both the main effects and the interaction effects were tested. The appropriate test statistic for this analysis is Wilks’ Lambda, and Table 2 presents the results of these tests.

**Teleconferencing Networks.** The results of the factorial MANOVA showed that the use of audio- and video-teleconferencing networks differed significantly on all three factors: degree of international involvement, its size and the industry it was in (See Table 2.) The interaction effects of these variables, while significant, did not add any additional explanatory power.

Although MANOVA can only distinguish the existence of differences among groups and cannot specify the direction of these differences, it is possible to evaluate the direction of such differences using univariate post-hoc tests. As results of these tests and the distribution of data suggest (Figures 3, 4 and 5) firms with greater international involvement, larger revenues, and in manufacturing industries tended to use international teleconferencing networks more than firms with lesser international involvement, smaller revenues, and in service industries. Results also showed that the top one third of the firms in terms of revenue generated overseas used video-conferencing at a rate five times that of firms in the bottom third of overseas revenue. These results suggest that video-conferencing offers firms with increased international

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**Figure 4: Technology Use by Firm Size (Technology Applications Only)**

**Figure 5: Technology Use by Type of Industry (Technology Applications Only)**
involvement an effective tool for handling a variety of communications across geographically and culturally diverse environments. Our results support Keen’s (1986) claim:

Videoconferencing ... is a major vehicle to support organizational redesign, especially for helping CEOs get their personality and message across to the field, for ad hoc problem solving, [and] for team and project work in a distributed environment... (p. 10)

Open ended comments made by executives in the survey also reinforce the message that large firms with significant international business tended to use video- and audio-teleconferencing networks quite heavily. The substantial cost of owning and maintaining proprietary international teleconferencing networks may preclude smaller firms from using this technology as heavily. However, with costs of such networks declining and the availability of networks-for-hire, smaller firms with less significant international business activities may also be able to take greater advantage of teleconferencing options in the future.

The fact that manufacturing firms were more likely to use these networks compared to other firms provides partial support for the findings of Steinbart and Nath (1992). In that study, manufacturing firms used global networks more for internal purposes than to exchange data with external entities. This may have been the case in this study as well. While we did not gather quantitative data on the kind of data exchanged and the parties involved, open-ended comments by some respondents—with a few notable exceptions—did indicate that they were using these networks to communicate internally. Cost and efficiency were cited as the most important reasons for using these networks.

**Messaging Systems.** This study provides the first empirical evidence about the nature and extent of messaging systems use in American MNCs. Results of the MANOVA indicated that the use of messaging systems was affected by all three independent variables—a firm’s degree of international involvement, its size and type of industry—individually and collectively. Figures 3, 4 and 5 provide a graphical overview of the results.

Generally, higher levels of international involvement and larger revenues were related to greater use of electronic messaging systems. There were significant increases in the use of both e-mail and voice messaging systems (VMS) by the largest firms and those with the highest degrees of international involvement compared to the smallest firms and those with the lowest degrees of international involvement respectively. While consistent with the view that large, geographically dispersed firms require increased communication, these results suggest that e-mail and VMS may not be substitutes for one another, but rather, complementary technologies.

Anecdotal evidence also suggests the increased use of electronic messaging systems by large, geographically dispersed firms. This quote from a *Business Week* Special Report (1988, p. 141) describes the use of e-mail at IBM:

One function of the (global) network is to connect IBM’s 400,000 employees: Last year it moved 3 trillion characters of internal information. Our electronic-mail network has replaced the telephone as the primary way IBMpeople communicate today,’ says Anne-Lee Verville, IBM’s director of information and telecommunication systems. She notes that wherever she is in the world, she can log onto the system and retrieve ‘mail’ that has been left for her.

The results from our study also suggest that firms in light manufacturing and service industries were likely to use international messaging systems more intensely than those in heavy manufacturing. The information intensity of these industries and the need to transmit a variety of information rapidly may account for these industry differences in the use

Table 2: Hypotheses Related to Use of Telecommunication Technologies

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<td>F=2.854</td>
</tr>
<tr>
<td></td>
<td>(.027)</td>
<td></td>
</tr>
<tr>
<td>(b) Messaging systems</td>
<td>Int’l Involv.</td>
<td>0.46894</td>
</tr>
<tr>
<td></td>
<td>(H1)</td>
<td>F=1.677</td>
</tr>
<tr>
<td></td>
<td>F=2.547</td>
<td>(.033)</td>
</tr>
<tr>
<td></td>
<td>(.014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Firm Size</td>
<td>0.72921</td>
</tr>
<tr>
<td></td>
<td>(H2)</td>
<td>F=2.181</td>
</tr>
<tr>
<td></td>
<td>(.035)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Industry</td>
<td>0.85280</td>
</tr>
<tr>
<td></td>
<td>(H3)</td>
<td>F=2.113</td>
</tr>
<tr>
<td></td>
<td>(.085)</td>
<td></td>
</tr>
<tr>
<td>(c) Interorganizational systems</td>
<td>Int’l Involv.</td>
<td>Not Significant</td>
</tr>
<tr>
<td></td>
<td>(H1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size x Industry</td>
<td>Not Significant</td>
</tr>
<tr>
<td>(d) Transmission media</td>
<td>Int’l Involv. x Size</td>
<td>Not Significant</td>
</tr>
<tr>
<td></td>
<td>(H2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size x Industry</td>
<td>Not Significant</td>
</tr>
</tbody>
</table>

Note: Cells include value of Wilks’ Lambda, F value and (Level of Significance)
of electronic messaging systems.

**Inter-organizational Systems.** Interestingly, use of inter-organizational systems like EDI with customers and vendors did not change significantly across a firm’s level of international involvement, the size of the firm or type of industry. As seen in Table 3, neither the main effects nor the interaction effects were significant. This suggests that EDI use is relatively comparable across manufacturing and service firms of different sizes, with varying degrees of international involvement.

A possible explanation is that, at its inception in the mid-1980’s, EDI was viewed by many as a source of competitive advantage. However, during the late 80’s with the increasing acceptance of EDI and the emergence of many competing systems within an industry, that view has changed. As one IS manager mentioned, EDI is no longer a competitive tool; *it has become an essential part of conducting business.* Today, for many firms in a variety of industries like automobiles, chemicals, and banking, inter-organizational systems have become an integral part of doing business. For instance, firms such as Ford and Mobil, among others have made it a requirement for suppliers (of certain components) to use EDI (Roche, 1991). Pantages (1989) reports the example of customers, distributors, and suppliers—of varying sizes, presumably—increasingly linking themselves to Texas Instruments’ global telecommunication network through EDI.

Open-ended comments from our respondents generally support the view that EDI has rapidly become a corporate necessity for all firms, large and small. Common sense dictates that if a firm wants to continue doing business with its larger clients, and these clients are EDI users (and advocates), the firm has little choice but to subscribe to the EDI network. Hence, it is no surprise that EDI use was not influenced by *firm size.*

The fact that EDI use does not appear to be affected by *industry type* contradicts conventional wisdom which states that certain industries are more likely to use EDI than others. Commonly cited examples include the heavy use of EDI in such industries as chemicals, banking, groceries and railroads. While such industry concentration may exist (Alavi and Young, 1991; Roche, 1991), our sample size of 105 firms—while comparable to that of other studies—may not have been adequate to detect differences across industries. Future studies need to undertake in-depth industry analyses of EDI adoption using data of finer granularity from larger samples; such studies could yield further insight into this issue.

**Transmission Media.** The overall use of transmission media did not differ significantly based on the level of a firm’s international involvement, its size, or industry type. As Table 2 shows, neither the main effects nor the interaction effects were significant. Firms of various sizes, with differing degrees of international business and from different industries, exhibited little difference in the types of international transmission media used. We discuss below the reasons for this apparently surprising result.

In an influential article about the evolution of SABRE, the American Airlines reservation system, Max Hopper (1990) outlined the notion of an *information technology platform,* i.e., a sort of an electronic highway that would provide a vehicle for integrating all types of organizational technologies and applications. In describing American Airlines’ own effort in that direction, he explained that their goal was not to develop stand-alone applications but to create a technology platform or “an electronic nervous system”. Such a system would be capable of supporting a vast array of present and future applications. Hence, the focus shifted from developing individual systems and technologies to building an organizational platform for information. Such a platform would require organizational commitment and technological know-how. This platform would also require a blend of various computing and communication technologies.

It was Hopper’s vision that all firms will—partly from necessity—move in this direction. Evidence from our study supports this contention. MNCs, in general, need to transmit complex types of data; this need requires a flexible infrastructure that will enable such diverse transmission. In order to achieve this objective, MNCs of different sizes, with varying levels of international involvement, and from various industries all appeared to be using a blend of technologies—leased lines, packet switching networks, dedicated FX lines, digital lines, fiber optic cables and VSATs. In essence, firms were relying on a portfolio of communication media to create the electronic platform that Hopper described.

As our results point out, this concept of an *electronic highway* for launching new and innovative technology applications cuts across organizational factors and industry types. In the future, the increasing reliance on such electronic highways by all firms conducting international business will transform computing and communication technologies from a source of competitive advantage to a corporate utility. As Hopper (1990, p. 125) states,

> Eventually—and we are far from this time—information systems will be thought of more like electricity or the telephone network than as a source of organizational advantage. In this world, a company trumpeting the appointment of a new chief information officer will seem as anachronistic as a company today naming a new vice president for water and gas.

**Hypotheses related to Relative Investment in Telecommunications Technology**

Spearman rank correlation coefficients were used to test hypotheses H4 and H5, while Kruskal-Wallis non-parametric analysis of variance was used to test hypothesis H6. Table 3 displays the results of these tests.

A strong correlation between *relative investment in telecommunications* and the *degree of international involve-
ment gives support for hypothesis H4. (The correlation was significant at an alpha level of less than 0.001.) Figure 6 presents graphical evidence of the relationship between a firm’s degree of international involvement and its relative investment in telecommunications. Indeed, firms with less than a third of their revenues from overseas had a relative telecommunications investment of about 0.3% while firms with over a third of their revenues from overseas had a relative investment of about 0.8%. This fact illustrates how firms with greater international involvement are investing more heavily in telecommunication technologies than firms with lesser involvement.

Hypothesis H5 was not supported, which indicates that there were no significant differences in the relative investment in telecommunications across firms of different sizes. The strong support for hypotheses H2a and H2b along with the lack of support for hypothesis H5 implies that while there was no significant difference in the relative level of investment across firms of different sizes, there was a significant difference in the type of investment. In other words, firms of different sizes were investing at comparable rates, but in different technologies. Although time series data were not studied, this result suggests that as firms expand, they may continue to invest at the same rate, but are likely to diversify into new technologies.

These results are consistent with the view that some of the technologies require a substantial investment which can only be justified by larger firms. However, this fact by itself should result in increased rates of investment by larger firms, which is contrary to our findings. Two possible explanations exist: (1) The additional technologies are substitutions for those currently being used; (2) Economies of scale exist for telecommunication technologies and firms are using these savings to invest in new technologies. Our findings tend to support the second explanation. We did not see much evidence of technology substitution; for example, the larger firms were heavy users of both electronic-mail and voice messaging systems; and similarly video- and audio-conferencing.

Hypothesis H6 was strongly supported, indicating that firms in different industries differ significantly in their levels of relative investment in telecommunication technologies. This support reveals different investment strategies across the manufacturing and service industries. For instance, the mean values for relative investment in telecommunications for the service, light, and heavy industries were 0.45%, 0.65%, and 0.23% respectively. (The mean value for the entire sample was 0.45%.)

Surprisingly, the heaviest investment in telecommunications was by firms in the light manufacturing industry. The relatively low level of investment by heavy industries is consistent with the lower level of information intensity associated with those industries. However, the fact that firms in light manufacturing were investing at a rate 50% higher than firms in the service industry contradicts the conventional wisdom that this sector is perhaps the most information intensive. It is possible that EDI systems are contributing to higher costs for the firms in light manufacturing, or that the service industries’ heavier use of digital communications is reducing costs to its member firms. More detailed data on the

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Support</th>
<th>Test</th>
<th>Value (Sig.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H4</strong>: The degree of international involvement is related to the relative investment in telecommunications technology.</td>
<td>Yes</td>
<td>Spearman Correlation</td>
<td>0.2928 (&lt;0.001)</td>
</tr>
<tr>
<td><strong>H5</strong>: The size of the firm is related to the relative investment in telecommunications technology.</td>
<td>No</td>
<td>Spearman Correlation</td>
<td>0.0555 (0.400)</td>
</tr>
<tr>
<td><strong>H6</strong>: The type of industry (a firm operates in) is related to the relative investment in telecommunications technology.</td>
<td>Yes</td>
<td>Kruskal-Wallis non-par. ANOVA</td>
<td>10.551 (.005)</td>
</tr>
</tbody>
</table>

Table 3: Hypotheses Related to Relative Investment in Telecommunication Technologies

![Figure 6: Relative Investment in Telecommunications by Degree of International Involvement](image-url)
volume of technology use and on investment into individual technologies are necessary to explain fully the relative investment differences between these two industry groups.

Summary and Conclusion

Results of this study suggest that technology-specific differences exist in MNCs across some factors. For instance, our results showed that the use of teleconferencing networks and messaging systems was distinguished by a firm’s level of international involvement, its size and industry type. In contrast, the use of inter-organizational systems like EDI was relatively constant across the board; i.e., there were no significant differences in use of IOS across firms with differing levels of international involvement, of various sizes and in different industries. These results support our contention—and the claim by analysts (for example, Hopper, 1990)—that some technologies like EDI are no longer being viewed as a source of competitive advantage, but as a corporate necessity. Thus, firms of all stripes are using inter-organizational systems to transact business. However, other technologies like teleconferencing networks and messaging systems, which may involve inter-organizational linkages—but which are used predominantly to communicate within the firm—are more likely to exhibit differences based on industry and organizational factors. In other words, these technologies tend to be used more by larger firms operating in information-intensive industries with significant international involvement.

The investment in telecommunication technologies by MNCs also exhibited some interesting patterns. Firms with greater international involvement were investing proportionately more in such technologies than those with lesser involvement. However, larger firms—relative to their size—were not investing more than smaller firms. As expected, the industry a firm operated in, did influence the level of investment in telecom technology. These results suggest that the level of a firm’s international involvement and the industry it operates in are better predictors of investment in telecommunication than its size per se.

The survey data revealed a significant increase in the relative level of investment in telecommunications for firms with over a third of their revenues from overseas. This increase, after controlling for differences in firm size, was still significant suggesting that high levels of international business produce size-independent coordination problems to which telecommunication technologies were being applied. Some of these results support findings from other studies (e.g., Deans, et al., 1991; Ives and Jarvenpaa, 1990) which suggest that firms operating in a global market have unique information technology requirements that differ from those of purely domestic firms.

While these results document a link between an MNC’s increased global presence and increased investment in, and use of, telecommunication technologies, the detailed nature of that link must be explored further. This study represents an initial step in understanding how to manage the complexities of global telecommunication systems. It is one of the first studies to empirically explore these important issues and confirms that telecommunication technologies are integral to the planning and execution of an MNC’s global strategy. Managers of MNCs can no longer relegate decisions about their global networks solely to technical personnel. The competitive global market demands an integrated technology-business strategy. Continued empirical and theoretical studies of international telecommunications will produce greater understanding of the factors influencing the design and success of these integrated strategies.

Endnote

1Faxes and telephones were not explicitly included because of their pervasity among businesses.

References


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