Telecommunications Technologies: Patterns of Usage

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Abstract

Technologies associated with telecommunications and computing are rapidly converging. It is therefore becoming difficult for IS practitioners to ignore telecommunications technologies and important for IS researchers to begin investigating them. This paper identifies a set of representative telecommunications technologies, and reports the results of a study undertaken to assess their usage in American industry. The data identifies technologies that are prominent and innovative as perceived by the executives surveyed.

We know about telecommunications technologies. We discuss them all the time. We realize their importance. But we are still a long way from making rational choices on how to use them. More often then not we play follow the leader. We have to. There are too many technologies that change too fast .... leading to many conflicting choices.

Vice President, IS, of a large manufacturer of food products.

INTRODUCTION

The telecommunications environment is confusing. Technological developments, regulatory changes, political idiosyncrasies, and an expanding telecommunications market are only some of the variables that corporations have to deal with today. And yet, these myriad of new communications technologies are widely recognized as being critical for business success. Despite the decline in costs of long distance communication, telecommunications costs have increased by a factor of 4 in many industries, over the past decade due to the increase in sheer volume of communications [Oldham, 1986]. This makes it visible to top management from purely a cost standpoint. Also, there is the concurrent recognition that telecommunications technologies can be used as tools to reach markets, create products and expand services. Examples of telecommunications-based systems such as Merrill Lynch's CMA, McKesson's Economost, American Hospital Supply's ASAP, Gannet's USA Today, American Airline's SABRE, among others, have been flaunted, as systems that have created competitive advantage for their initiators [Bundy, 1986; Neo, 1988]. As a result of this, we are experiencing a transformation of sorts, where the focus is not on the "islands of information" but the connections between them. Before the dust has settled on the CIO as the lord of the organizational information jungle, we are beginning to replace him with the CNO [Donovan, 1988] the manager of value, where it now counts - the communications network.

Keen [1988], describes the change in the telecommunications environment as a transformation from an operations era dominated by the plain old telephone system (POTS) to an internal utility era. The change began in 1982 with the divestiture of AT&T. Three trends began to develop at this point: (1) the proliferation of new vendors and products in what had been a very stable industry dominated by AT&T (2) the increasing convergence of communications and computing as inextricable components of the new information technology (IT) fabric of an organization (3) a growing recognition of the impact that telecommunications could have on key business functions. These trends brought opportunities for those who could leverage them to their advantage, and problems for those who couldn't.

Surprisingly, despite the acknowledged importance of telecommunications technologies [Scherr, 1983; Keen, 1988; Clemons and McFarlan, 1986; Sullivan and Smart, 1987; Hammer and Mangurian, 1987], very little is known or understood about how American organizations in general (besides the prominent examples mentioned above) are using them. With the convergence of communications and computing, telecommunications is increasingly becoming an indispensable component of IS practice and research [Scherr, 1983].

Unfortunately, there have been very few articles in the IS literature that focus on telecommunications technologies. Those that do either discuss specific implementations of networks or applications [Manross and Rice, 1986; Crawford, 1982; Grant, 1986; Kriebel and Strong, 1984; McCauley, 1983; Montgomery and Benbasat, 1983] or the impact of telecommunications on business strategy [Johnston and Carrico, 1988; Johnston and Vitale, 1988; Runge, 1985; Barrett and Konsynski, 1982; Cash and Konsynski, 1985].

This paper reports the results of an exploratory study on the usage telecommunications technologies (henceforth referred to as TT). The questions addressed include: Which technologies are being adopted and implemented? Are they being inter-organizationally implemented? Which technologies are currently viewed as more innovative by senior executives?

THE STUDY

Identification of TTs

An initial set of technologies was identified through a review of books and papers that dealt with TTs [e.g., Roche, 1991; Misra and Belitsos, 1987; Keen, 1988; Fitzgerald, 1990; Straub and Wetherbe, 1989]. This initial list of TTs was then mailed to a panel of six experts, three academic and three practitioners, for evaluation. Of the academic experts, two were actively involved in research on the impacts of TTs and other technologies on organizational effectiveness. The third was a professor of electrical engineering with a specialization in electronic communications. All three practitioners were engaged in the management and implementation of TTs in their respective organizations.

The panel was asked to add, delete or combine TTs from the list as they deemed necessary to arrive at a set of representative technologies. The researchers then reconciled feedback from the panel into a set of fifteen TTs that were used in the final questionnaire. It should be emphasized that these technologies are not mutually exclusive. They represent a myriad of technology platforms, equipment and applications that can give us a descriptive perspective on the telecommunications environment. More importantly, these TTs emerged as representative of important independent initiatives on the part of individual firms. Obviously Local Area Networks or Wide Area Networks need to be in place before electronic mail applications can be developed. However, the decision to develop an electronic mail system is the prerogative of the initiating organization. The TTs identified are described below:

1. Intelligent/mobile phones. Cellular and associated wireless communication technologies that can and are carried within and external to the organization. Ex-

amples include executive mobile car phones, beepers, and service vehicle communications.

2. Voice/data PBX (internal telephone system). The traditional telephone system used by industry to transfer data and voice across corporate sites and to support individual on-line communications. PBXs typically contain features that facilitate the management and cost control of the intra-organizational telephone system.

3. Voice oriented systems. Technologies that combine the features of telephone conversations and postal mail: the spontaneity of picking up the phone and the time independence of a letter. The voice system, usually attached to the PBX, facilitates asynchronous interpersonal communication (e.g., voice mail).

4. Integrated Services Digital Network (ISDN). An increasingly viable communications approach, requiring specialized hardware and software, enabling concurrent transmission of video, data, and voice media. End to end digital connectivity (as opposed to analog) and standardized network elements (line capacities, PBXs, switching facilities, etc.) are the goals of ISDN. Currently being installed and operated on a regional and often trial basis by larger firms.

5. Local Area Networks (LAN). Hardware and software installed to link individual and business unit computer workstations within a confined geographic region. Integration enables a variety of information flows including migration of data files, spreadsheets, mail, as well as common access to application and system software.

6. Wide Area Networks (WAN). Communication technologies that link widely dispersed business units.

7. Facsimile (FAX). Technology enabling transmission of documents electronically.

8. Electronic Mail (E-Mail). Electronic messaging normally conducted on an asynchronous based on person to person(s) flow (compared to computer to computer communications).

9. Video Conferencing. Those technologies which facilitate business seminars and meetings across physical distances. Conference participants may both view and talk with each other interactively without being literally present.

10. Video Text. Integration of video, text, and user intervention for multi-media exposure. Usually allows users with no training to access information, or graphics. This technology is often applied in educational and training environments.

11. Value Added Network (VAN). Communication lines offered through common carriers that facilitate timely and accurate information flow. "Value added" includes processing services such as error checking, re transmission, and alternate routing in case of network node failure.

12. Access To Commercial Data Bases. The capability to logon to external databases (for a fee) for access to data to maintain and advance the competitive market position of a corporation.

13. Network Management Software. Systems software to operate and monitor computer network communications activities. Examples of these activities include remote diagnostics, detection of link failure, dynamic on-line help/status facility, examination of network log to check parameters, etc.

14. Interorganizational Communications Links. Bridging and conversion technologies that enable transmission and receipt of such items as documents, transactional data, functional information, and planning perspectives across organizational boundaries (e.g., with customers, suppliers).

15. Corporate Owned Communication Lines. Corporate ownership of the communications medium (e.g., co-axial cable, fiber optic link, microwave link) as opposed to using links through a common carrier. This ownership implies that the company is totally responsible for the design, engineering, installation, operation and maintenance of the line.

Corporate owned communication lines and network management software were added to the initial list by three members of the panel. Systems involving EDI, JIT or links with customers to facilitate sales of goods and services were combined under Interorganizational Communication Links.

Instrument Development

A questionnaire was developed to measure the use (i.e., evaluation, adoption and implementation) of each TT identified. These constructs parallel the three phase model of initiation, adoption and implementation proposed in the innovation literature [Thompson, 1965; Pierce and Delbecq, 1977].

Respondents were asked to identify for each technology, whether it had been formally evaluated (assessed) for possible adoption? A simple dichotomous scale was used to capture the response (yes or no). Similarly, adoption was measured by asking respondents whether a decision had been made to adopt the TT (yes or no). While the objective of this study is descriptive, i.e., to report on the use of these technologies, other studies have used similar dichotomous measures and

aggregated them over sets of innovations, in order to measure overall initiation or adoption [Zmud, 1982; Moch and Morse, 1977].

Implementation was measured on a 7-point Likert scale ranging from "not implemented" to "extensively implemented" for each TT. Since the instrument was directed at corporate centers, the extent of implementation should reflect the degree to which the TT had been implemented (i.e., set up) throughout the organization. Similar measures were used by Zmud [1982] in measuring the implementation of individual software practices.

Another measure, innovativeness was assessed for each TT. This represents the uniqueness or novelty of the technology as perceived by the respondent. The diverse and dynamic nature of TTs warranted a measure with the ability to separate the more routine technologies from the novel ones. While there is no theoretical basis by which we can evaluate the novelty of a technology, empirical work in technological innovation has used such a measure [e.g., Moch and Morse, 1977; Dewar and Dutton, 1986]. The concept is similar to the dichotomy of radical (departure from existing practice) vs. incremental (minor improvements) technologies, described in the innovation literature [Ettlie, et. al., 1984]. This variable was also captured on a 7-point scale ranging from "not innovative" to "very innovative". Respondents were also asked to indicate (yes or no) whether certain TTs were implemented between the organization and another organization (e.g., supplier or customer organization). An illustration of the items is provided in the Appendix.

Sample

The respondents were senior IS executives randomly selected from the Standard and Poor's 1991 Corporate guide and The Information Week 500. 777 questionnaires were effectively mailed (i.e., were not returned due to change of address). 165 responses were received of which 154 were usable resulting in a response rate of about 21%.

Most of these organizations are presumably forerunners in the use of information technologies by virtue of their larger size (average sales over $300 million). 63% of the sample consists of manufacturing and finance firms. Almost 65% of the respondents surveyed were at the Director, Vice-President or a higher level in the organization as indicated by their title. Most of them were in charge of significant IS/Telecommunications operations which enhances their ability to respond to questions on specific telecommunications technologies.

USAGE OF TELECOMMUNICATIONS TECHNOLOGIES

Tables 1-4 describe results related to the usage of TTs. These are discussed individually below.

Technology Categories

Table 1 categorizes the 15 technologies, based on the responses to the evaluation, adoption and implementation questions. The groups are significantly different (p<0.01) on their mean implementation score.

Table 1
Technology Evaluation, Adoption and Implementation

Technology	% Evaluated	% Adopted	Implementation Score (7 Point Scale) Mean	SD
Category 1				
1. FAX	99.4	99.4	5.8	1.3
2. Voice/Data PBX	93.5	85.7	5.1	2.5
Category 2				
3. Access to Commercial Databases	90.3	85.7	3.1	1.9
4. Electronic Mail	96.1	87.7	4.4	2.4
5. Interorganizational Links	91.6	88.3	3.5	2.1
6. Local Area Networks (LAN)	97.4	92.9	4.8	1.9
7. Network Management Software	91.6	84.4	4.0	2.3
8. Voice Oriented Systems (e.g., voice mail)	95.5	85.7	4.4	2.4
9. Wide Area Networks (WAN)	89.0	77.3	4.3	2.8
Category 3				
10. Intelligent/Mobile Phones	76.6	69.5	2.4	2.0
11. Owned Communication Lines	74.7	60.4	2.9	2.8
12. ISDN	66.2	31.8	.9	1.7
13. Value Added Network	85.1	68.2	2.7	2.4
14. Video Conferencing	72.7	37.0	1.2	2.0
15. Video Text	40.9	22.1	.7	1.6

Category 1 includes technologies that have been formally evaluated by most firms (>90%), have consequently been adopted (>80%) and have also been extensively implemented (>5.0). This category includes TTs such as coice/data PBXs and FAX that are relatively mature and are being routinely used by businesses.

Category 2 includes technologies that have been formally evaluated by most firms (>90%), adopted by most firms (>80%) and have been moderately implemented (3-4). These include voice systems, LAN, WAN, E-mail, network management software, commercial database access and inter-organizational links. While not as extensively implemented as category 1 technologies, these TTs seemed to have been formally assessed by almost all the firms in the sample.

Category 3 includes technologies that have been formally evaluated by many firms (>40%), but relatively less have chosen to adopt it, and have not been extensively implemented among adopters (i.e., <3). These include expensive technologies or those that have unique applications like ISDN, videoconferencing, VANs, owned communications lines, videotext and intelligent/mobile phones.

Table 2
Innovativeness of Telecommunications Technologies
(listed in descending order)

Technology	Innovativeness Score (S.D.)
ISDN	5.33 (1.28)
Videoconferencing	5.31 (1.29)
Interorganizational links	5.07 (1.27)
Local Area Networks	5.05 (1.35)
Wide Area Networks	5.05 (1.45)
Network Management Software	4.81 (1.34)
Voice oriented systems (voice mail)	4.80 (1.46)
E-Mail	4.67 (1.38)
Videotext	4.69 (1.28)
Intelligent/mobile phones	4.65 (1.29)
Corporate owned communications lines	4.42 (1.48)
Value Added Network	4.35 (1.30)
Voice/data PBX (internal telephone)	4.32 (1.68)
FAX	4.29 (1.73)
Access to commercial database	4.15 (1.36)

Technology Innovativeness

Table 2 ranks the 15 technologies in descending order of innovativeness, as computed by the average innovativeness score given to each TT. The order of the technologies expectedly corresponds to the categories in Table 1, i.e., TTs with higher usage are viewed as less innovative. The exception are some category 3 technologies: videotext, intelligent/mobile phones and corporate owned communications lines. These technologies are not highly innovative, yet they have a relatively low level of usage.

Videotext was touted as one of the most promising technologies in the early eighties. However, questions of economic viability and low value added by the technology, and the commercial failure of many commercial videotext ventures, facilitated its decline [Noll, 1985; Grover and Sabherwal, 1989]. Results of this survey reflect the low relative usage of videotext in corporate environments. However, this could be misleading, since educational institutions and libraries which are primary users of videotext are underrepresented in the sample. Nevertheless, with declining costs of computing and communication and greater bandwidths of transmission channels, videotext could play a major role in intra-company communications or for marketing of products and services.

Mobile/intelligent phones are also not very innovative and yet are not extensively used. One reason for this could be the specialized nature of the technology. Usage is important for companies that have a need to communicate when "on the road". Federal Express uses them extensively in their system, as do many radio paging companies. The potential of this technology however is significant as it is based on the philosophy of dividing communicable areas of the earth into smaller and smaller addressable cells.

The last discrepancy is on corporate-owned communication lines. This practice is not as widely prevalent or implemented as some of the other TTs. A possible explanation for this is the diversity and flexibility of programmable services being offered by the major common carriers (e.g., AT&T, MCI) to corporate clients that make it unnecessary to "own" lines. Wide area networks can easily be dedicated to the company by leasing lines through the common carrier.

Table 3
Ranking of Technology Innovativeness by Industry

			——Ranking by Industry——				
Technology	M	F	W	U	Pu	P	T
Interorganizational links	#1	#5	#5	#4	#5	#8	#3
ISDN	#2	#2	#1	#2	#1	#4	#1
Videoconferencing	#3	#1	#3	#1	#11	#7	#5
Local Area Networks	#4	#3	#6	#8	#2	#3	#10
Network Management Software	#5	#10	#12	#3	#4	#12	#2
Wide Area Networks	#6	#4	#4	#5	#6	#2	#7
Videotext	#7	#8	#7	#6	#7	#14	#11
Voice oriented systems (voice mail)	#8	#6	#2	#11	#9	#5	#8
E-Mail	#9	#7	#10	#14	#3	#6	#9
Corporate owned communications lines	#10	#15	#13	#15	#15	#13	#6
Intelligent/mobile phones	#11	#9	#9	#13	#13	#1	#4
Value Added Network	#12	#12	#11	#9	#8	#11	#12
Voice/data PBX (internal telephone)	#13	#11	#8	#10	#14	#15	#15
FAX	#14	#13	#14	#7	#12	#9	#14
Access to commercial database	#15	#14	#15	#12	#10	#10	#13
Sample size (# of companies)	48	49	17	9	5	5	11

Legend for Industry:
Manufacturing (M)
Finance/Insurance (F)
Wholesale (W)
Utility (U)
Publishers (Pu)
Petroleum (P)
Transportation (T)
Other (O)

Table 3, ranks the innovativeness scores, by industry. This table provides some additional insights into the usage of these technologies. It should be pointed out however, that with the exception of manufacturing (M), finance (F) and wholesale (W), results for other industries are based on smaller sample sizes (i.e., less than 15) and should therefore be interpreted with caution. Some of the more interesting results from Table 3 are highlighted below:

- Intelligent/mobile phones are considered to be innovative TTs in publishing and transportation industries.

- ISDN is a consistently innovative TT across industries.

- Videoconferencing is highly innovative in all industries with the exception of publishing.

- Network management software is also considered highly innovative use of TT in all industries, with the exception of those dominated by networks: finance and wholesale.

- Inter-organizational linkages with customers or suppliers are considered more innovative in manufacturing industries.

Table 4
Inter-Organizational Implementations

	——Percentage of Firms——	
	Adopted % (Rank)	Inter-Organizational Implementation % (Rank)
Local Area Network	92.9 (1)	25.3 (5)
E-Mail	87.7 (2)	55.2 (1)
Voice/Data PBX	85.7 (3)	36.4 (4)
Voice oriented systems (e.g. Voice mail)	85.7 (4)	43.5 (3)
Wide Area Network (WAN)	77.3 (5)	53.2 (2)
Corporate owned lines	60.4 (6)	22.1 (6)
Video Conferencing	37.0 (7)	20.1 (7)
Integrated Services Digital Network (ISDN)	31.8 (8)	8.4 (8)
Videotext	22.1 (9)	7.1 (9)

Table 4 describes the percentage of companies that had inter-organizationally implemented these technologies[1] (e.g., e-mail with customers, corporate owned lines or ISDN links with suppliers). The TTs are in order of their overall adoption (column 1). Wide area networks and e-mail were among the more common TTs implemented inter- organizationally, while videotext and ISDN were among the least. The rankings in the table suggest that TTs that tend to be highly adopted also tend to have higher inter-organizational implementation. Exceptions are LANs, which are used more for intra-company communications and WANs, which are implemented for a wider geographical area, and tend to cross organizational boundaries.

It is interesting to note that for videoconferencing, which has only a 37% adoption rate, over half of these companies have interorganizational implementations. This suggests that videoconferencing facilitates meetings not only between geographically dispersed groups within an organization but also across organizations (for instance, with customer groups).

DISCUSSION

A convergence of computing and communications is currently underway: both technologically and organizationally. The rapidly improving cost/capacity ratios of processing and storage technologies is creating the need to transfer massive amounts of information between individuals, groups, and organizations. Communication technologies provide the means to do this. Perhaps the most significant transformation being undertaken with respect to TTs is the gradual phasing out of conventional analog transmissions in order to harness the power of digitalization. Digital transmissions can more efficiently take advantage of very large scale integrated circuitry (VLSI), utilize the wider bandwidths available through fiber optic media, reduce all information that is processed and stored to a common denominator, and integrate data, video, text and voice over single multiplexed lines. Each one of the set of technologies identified in this study is undergoing such a transformation. The patterns of usage described in this paper, while making no pretensions of comprehensiveness, provide insight into the use of these diverse set of TTs in American businesses.

Three sets of technologies were identified, based on their extent of initiation, adoption and implementation. The first set consists of FAX and PBX, which are viewed as relatively less innovative technologies. These technologies are well integrated into all businesses and are being used routinely. Newer FAX machines are exclusively digital and offer higher resolutions. It is questionable however, whether the form of FAX will remain the same in a more highly integrated paperless environment. Most personal computers can be easily converted into FAX machines, thereby allowing direct transfer of documents in digital form. Even PBXs today offer a wide variety of digital services to the internal telephone system by using microprocessor chips as the central intelligence.

The second set of technologies consist of networks or TTs that require a network base. These include LANs, WANs, voice and mail systems, commercial database access, interorganizational links, and network management software. These technologies directly affect (a) the way people, groups and organizations interact, (b) the sharing of resources across disparate units, and (c) the ability to access large amounts of stored information. The high bandwidths being offered by fiber optic cable, is rapidly making it the medium of choice for these TTs. These technologies, have been adopted by a majority of the organizations surveyed. However, their extent of implementation is lower than the first group. The unidimensional nature of the implementation measure does not provide much insight into the breadth and depth of implementation. We would suspect however that while many of these network technologies are commonplace in certain business units, they have not yet achieved the widespread penetration afforded by group 1 technologies. However, these TTs are here to stay and cause fundamental changes in the ways business is conducted. Reduction of information float, ability

to recapture scale economies, simultaneous micro and macro control, ability to bypass formal structures, and the ability to assemble and dismantle groups and expertise will facilitate the redesign of business processes and structures through these TTs. Interestingly, organizations are using some of these TTs inter organizationally. Over half of the organizations using electronic and voice mail systems, were using them inter organizationally. While there are relatively fewer LANs and PBXs implemented inter organizationally, the growing information integration, regardless of organizational or geographic boundaries should increase the number of interorganizational TT implementations.

Finally, the third group of TTs represents some specialized or innovative technologies that have yet to experience extensive implementation. Of these, mobile phones and VANs typically would be used based on the nature of the business. Corporate owned communication lines might not be economical due to the ease of leasing lines through a common carrier. Video conferencing is both specialized and expensive to construct and might not economically justifiable in many organizations. The use of microprocessors with communication capabilities might have usurped the utility of videotext as originally conceived (i.e., low cost terminal for accessing information interactively). And, ISDN, while much touted, has been slow to be widely adopted. Conversion to ISDN standards presents a risk to companies who often prefer to implement proprietary solutions than wait for standardized products to become available. All the industries represented in our sample viewed ISDN as an innovative TT. However few have committed to ISDN standards.

On a final note, this study attempts to raise the awareness of telecommunications technologies and profiles the usage of a set of these technologies in American businesses. It is important for IS research, as it is practice, to begin to recognize the inextricable nature of these technologies as a part of the information technology infrastructure of firms. The impact of these technologies manifests itself in its achievement of time and space compression. The repercussions of such compression is changing organizational form and function. It is the responsibility of IS researchers to provide insight into the effective management of such change. To do this, we need to understand the agent (technology), the effect (on individuals, tasks, groups, processes, organizations, industries) and the effective and efficient match between technology and effect. The descriptive work reported here is only a first step in the assessment of this group of technologies that is only going to grow in importance in the future.

Endnote

[1] The inter-organizational implementations of TTs were not assessed for VANs, FAX, access to commercial databases and interorganizational communication links since these would naturally involve links with multiple organizations. Also, links between organizations for network software and mobile phones were not assessed because they do not make sense.

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