TELECOMMUNICATIONS: THE ISSUES

Tibor Vasko

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
2361 Laxenburg, Austria

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PREFACE

The telecommunication sector is having important economic and social impacts, as recent innovations enhance the performance of old services and create new ones. The nature of telecommunications makes it difficult to analyze and assess the impact of individual services: one has to take into account economic, technical, organizational, and not seldom, political and social questions.

In this working paper an attempt is made to formulate the problems that most challenge the management of innovation in the telecommunication sector. The main aims of the paper are to provide a platform for discussion and to present a selection of topics for a more detailed collaborative study.

Alec Lee

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INTRODUCTION

Telecommunication technology—despite its century-old history-- is facing important new challenges brought about by recent advances in electronic technology. There have been major changes not only in the physical representation of messages and the media carrying them, but also in the nature of the messages being communicated. Entire information packages are being added to private messages; in the future, it will be possible to transmit whole information and knowledge bases (Masuda 1972).

Telecommunication enhanced by computers represents the core of information technology, which, it is believed, will stamp the character of future society. It is said that some societies are already reaching this stage (see Parker 1972). Gassmann (1981) has suggested that information technology and services be considered a fourth economic sector.

It seems that every production technology that lent its name to a cultural era in the past better obeyed the laws of economics than does information technology, whose economic and social impacts extend far beyond productivity and production. The effects of information technology seem to be more mediated and indirect, and as a result, more difficult to assess, even when they have been clearly identified.

But this in itself, i.e., identifying the potential impacts of information technology, is very difficult. We might speculate that this might be because information is a companion of creativity. Even in the last century, it was clear to philosophers that creativity defies the bookkeeping

(cause and direct effect) character of the majority of economic theories.

This encumbers with many uncertainties the exploration of the role of information in society and makes difficult the accurate forecasting of information demand. And it is from this demand that one must deduce the demand on telecommunications.

While the following issues address more specific problems, all are related to the general task of acquiring new knowledge relevant to this distinctive sector.

THE ROLE OF TELECOMMUNICATIONS IN THE NATIONAL ECONOMY

The easiest way to assess the role of telecommunications in the national economy is to relate it to the resources spent on it (inputs), in terms of both capital and labor. A random glance through the wealth of literature on telecommunications reveals a wide spectrum of data, some of which are somewhat contradictory, mostly because of differences in the methodologies used or in the application of definitions.

Gill (1975) estimates that in the late 1960s investments in telecommunications by PTTs and other carriers ranged from 0.45% to 0.90% of the GDPs of the US, Sweden, the UK and France. In the total of all investments (Gross Fixed Capital Formation) the share of telecommunications in this period ranged from 1.7% in France to 4.0% in the United Kingdom.

This growth trend seems to have continued in the 1970s; at the same time differences among countries have been narrowing. Dondoux (1977) claims that in several countries the share of telecommunications in the GDP has exceeded 10%.

The cost of telecommunication in business is also high. Kimball (1977) indicates that in 1974 DM 22 billion were spent in the FRG on business communications comprising telephones, correspondence, telexing, and business travel. When related expenses for personnel and equipment are included, the amount reaches 12.5 billion (13% of the GNP). Of this sum, 37% is spent on telecommunications, 41% on correspondence.

The labor input is also considered very important. Early in the history of telecommunications it was recognized that some technologies (manual telephone switching, for example) were so labor-intensive that a limited labor supply could hamper the development of the whole sector. This provided a strong motivation for innovation and led to increased substitution of capital for labor. Now labor input is no longer a constraint in the telecommunications sector.

The transmission of information has become very efficient. Perhaps this—together with the general tendency S. Nora calls "l'informatization" of society--has contributed to the major shift of the working population toward information handling activities. In his widely known study, Porat (1977) pointed out that 50% of the US civilian labor force is engaged in information- intensive activities and that 46% of the US GNP is derived from the production, processing, and distribution of information goods and services.

Should the information handling (recent computers) proceed the same way as information transmission (telecommunications) did several decades before it, one could conclude that it needs substantial innovation.

Telecommunications represents a significant part of research and developmet activities. In most countries the financial resources devoted to this activity (as a percentage of sales) is higher than in most other industries (except computers). In the US, for example, the percentage is twice as high as for manufacturing industry as a whole (Agnew, Romeo 1981).

While there may be differences in the level of inputs to the telecommunication sector among countries, there seems to be a general trend toward higher shares in the use of resources.

The increased importance of modern telecommunications has led to the introduction of the notion of an electronic infrastructure in the national economy whose major component is telecommunications. Kapitonov (1980) argues that in the CMEA countries telecommunications is part of an emerging international production infrastructure. The management of a modern economy requires many coordinated but locally decentralized decisions for which computers and telecommunications are indispensable. In the USSR some estimates were made of how many arithmetic calculations are required per year in the process of managing the national economy during the 1960s. The result was 10^{16} (Glushkov 1974).

As for the society as a whole, related data on information handling capability were given by R.N. Noyce (1977), who concluded that there are 50,000 electronic logic functions per capita in use in the US, and that this may grow by a factor of 10 in the next five years. This might lead to a situation in which each person could command the capabilities of a powerful computer.

These considerations do not take into account indirect, secondary, and difficult to assess effects of widespread use of information technology made possible by the availability of telecommunications, such as the enhancing of the creativity of users, increasing the efficiency of the education process, etc.

Centain impediments appear to be inherent in efforts to identify the impact of this technology, because as it is correctly argued by G.B. Thompson (1979), not only is information as an economic good different from other goods, but the technology connected with it is also unique. If we forget this fact we may miss the main specific contribution of this technology (much as did the one who discovered that when photographic plates are kept close to the discharge tubes, they become black and that it might be better to store them elsewhere--to Roentgen this same information was sufficient to discover x-rays.)

The Issues: *What assessments exist (and how reliable are they) for estimating both the magnitude of information-related activities in a national economy and the role of telecommunications in these activities? What generalizations might be drawn from a study of innovation in the*

telecommunication sector in various countries at differing stages of telecommunication development?

INNOVATION POTENTIAL IN TELECOMMUNICATIONS AND ITS SOURCE

The cost/performance ratio of modern electronic components has led to innovative equipment and services in the telecommunications sector. A case in point is the high rate of penetration of LSI/VLSI-based semi-conductor components in telecommunications equipment. Detailed studies reveal that microcircuits have been incorporated into the design of virtually every major category of telecommunications device (Melvin 1980), including:

- high feature telephone sets (with custom-made microprocessors)
- multiple-line key telephone equipment
- voice/data terminal equipment
- private automatic branch exchange (PABX) switching systems
- subscriber loop multiplex systems
- central office switching systems
- inter-office line and microwave digital transmission systems

LSI circuits frequently combine analog and digital functions in a single device. This reflects the trend toward replacing analog signals with digital ones at the component level, a trend also seen at the equipment and network levels. Worldwide shipments of modems amounted to nearly 400,000 units in 1978; 1,200,000 units are projected for 1983. This indicates an annual growth rate of approximately 25%.

As remote devices become more reliable, the technological trend is toward a decentralization of control in telecommunications networks through an increasing amount of remote intelligence. Improvements in telecommunication technology include digital encoding and digital signal transmission and processing (PCM, delta), greater efficiency in communication media capacity sharing, new switching techniques, fiber optics, and satellite transmission.

Satellites have developed very rapidly since their appearance in 1960. Fourteen commercial communication satellites were placed in stationary orbit in the 1970s and it is estimated that nearly 100 additional satellites were in orbit at the beginning of 1981. There has been a 50-fold increase in communication satellite capacity with a corresponding decrease in cost per circuit per year since the first stationary communications satellite was launched. Bell Telephone Laboratories expects world traffic to reach 2,000,000 satellite circuits by the year 2000.

Compared with classical copper wire systems, fiber optic transmission systems offer large information capacity, greater protection against interception, low error rate (due to freedom from cross talk and electrical radiation), and low cost. However, optical fibers still require special handling and cannot yet fully replace copper wires. The price of fiber optic cable is dropping rapidly: according to a 1979 study by Probe

Research, Inc., the price was expected to have declined from US $13,000 per kilometer in 1978 to US $6,700 in 1981. It was predicted that the price of fiber optic cables would drop below the price of copper cables by the end of 1981 at the latest.

There is an increasing movement toward the integration of communication services. This involves integration of functions, e.g., the integration of transmissions with switching techniques and devices, and will eventually enable a unified computer controller network to transmit voice, video, data, and facsimile and in this way, to integrate services as well. This will eliminate the clear technical distinction between telecommunications and computer services.

The Research Needs: *To forecast the likely effects of present and future technological developments in telecommunications and the barriers to their implementation. To investigate the innovation process at the enterprise level to determine the effectiveness of incentives and the appropriate management of the innovation process.*

SECTORAL EFFICIENCY

The rate of increase in productivity in the telecommunications sector is considered to be above the average rate for all industries and services. For example, in the FRG, productivity in the telecommunications branch (in terms of traffic volume per person) increased sixfold between 1950 and 1975. (See Elias 1976.) Overall productivity in the FRG nearly doubled during the same time span, taking into account all factors involved in production. Data from the US convey a similar picture (Agnew, Romeo 1981).

Capital formation plays an important role in the telecommunications sector. Figures vary from country to country, but in general, the share of telecommunications is high. Elias (1976) for example, states that the German Federal Post Office made investments corresponding to one-sixth of all investment in industry in the Federal Republic of Germany.

The telecommunications sector manifests many natural economies of scale that affect the policies and regulations of firms (regulation of monopolies) and governmental agencies within the sector. Whether or not a new technology is introduced will largely depend on the extent to which it can take advantage of economies of scale.

Innovative capacity is also dependent on the size of the firm or the degree of concentration within the branch. The degree of concentration that is optimal for eliciting creative behavior has not yet been established.

An important question that has been studied elsewhere is what is the impact of R & D on productivity and on the efficiency of telecommunications. This question is difficult to answer conclusively for any sector; in the telecommunication sector, which is not easily amenable to standard classification and data collection schemes, it is even more difficult. In addition, regulation makes the real impact difficult to assess. Rates of

return on innovations in this sector are very low, perhaps because regulation prevents companies from appropriating the gains of innovative activities (Griliches 1980). This may discourage innovators.

The Research Needs: *To study problems of productivity in the telecommunications sector, with special emphasis on economies of scale and their effect on the labor force in the context of innovation. To study the degree of concentration (size of companies) in this sector in order to determine the relationship between size and innovative behavior. To investigate the effectiveness of innovative technology in stimulating capital formation in the telecommunications sector.*

SELECTION ENVIRONMENT

Innovation, the modification of a particular service or product or the introduction of a new one, is largely dependent on economic and social environment. In telecommunications the decision to innovate must be based on consideration of a number of factors that are not always present in other sectors.

The worldwide telecommunications system with its more than 500 million telephones is the largest man-made machine, a machine that should be designed to meet the criteria of effectiveness and reliability. The implementation of any technological change in this system must take into account

- amortization requirements of equipment currently in use
- the compatibility of the technical innovation with the rest of the network
- the revenue requirements of the new technology
- the needs of the user
- policy regulations
- personnel requirements (increased or decreased) and training
- the market situation, standards, CCITT recommendations, etc.

These factors help create the environment that motivates the selection of a particular innovation from the set of potentially available ones.

The Research Need: *To analyze the economic, political, and social components of the selection environment and its function in different services and in different countries.*

THE RELATION OF TELECOMMUNICATIONS TO OTHER SECTORS

The telecommunications sector has close links with other sectors of the national economy, especially manufacturing, and particularly in recent years, the computer industry. Telecommunications makes it possible for users to access remote data bases and also facilitates the creation of distributed data processing networks.

Microelectronic components have functionally replaced electromechanical devices and hard-wired control, increasing telecommunications' flexibility and reliability, as well as improving its performance/cost ratio, especially from the point of view of service vendors.

As the price of energy has increased, telecommunications has become a potential instrument for promoting energy conservation, by improving the efficiency of transport, and in some cases, by partially replacing it. Energy saving has become one of the objectives of innovation and policy design in telecommunication (Day 1978).

The effects of telecommunications are also felt in the administrative branch, where the so-called "electronic office" may radically change the way offices operate. The "office of the future" features

- teletex service for inter-office correspondence (with high transmission rate, ISO-7 codes, automatic distribution, and automated receiving)
- electronic mail, based on computer control and processing, with "store and forward capability"
- centralized filing, with remote file access
- teleconferencing, etc.

The introduction of electronic fund transfers will have a significant impact on banking, and will create new problems of reliability, privacy, security, etc.

The Research Need: *To better understand the impact of other sectors on the innovation potential and management of telecommunications.*

THE POLICY ISSUES

The specific properties of telecommunication named above are making the design of an optimal policy (assuming we know what the criterion for optimality is) very difficult. These properties seem to trigger off policy issues unlike those economist and policy makers are accustomed to facing.

Telecommunications are regulated in virtually every country, although there are significant policy differences among nations. The oldest regulations affecting the telephone industry are in the US, where rate-level regulation is used. The limited range of this regulation has been acknowledged and discussed for more than half a century. New and hopefully better methods are now being sought, but the diversification of telecommunication services makes the choice difficult. In addition, regulators are faced with a lack of sufficient information (Ryan 1981).

Telecommunications policy issues inevitably involve economic matters. Social aspects are becoming increasingly involved as well. Ideal perhaps, would be to identify and implement innovations that are technically possible, economically attractive, and socially useful. But such an accomplishment would be very difficult, perhaps infeasible. Instead the problem may be one of trade-offs.

Some important technical policy problems relate to standards. In telecommunications, where the exchange of information involves not only interstate links but also international ones, standards (generally established as CCITT recommendations) become essential and are not entirely within national control. These standards apply to interfaces at the borders, and include performance capability.

At the level of the national economy, the policy issues include

- the management of the telecommunications sector development in the scope of the national economy
- the priority to be given to telecommunications in the economic and social development of a country
- what services to introduce, and when to do so; what measures to use to stimulate development in the desired direction
- how to do this in a technically "turbulent" environment, in which many decisions are burdened with risk

Important social issues includes the effect of telecommunications on

- lifestyles
- labor force, jobs, etc.
- crime control
- privacy

As important as the formulation of policies are the instruments for implementing them. This is important because many new telecommunication services (e.g., services aimed at educating or at enhancing public participation) are not compatible with the traditional market.

The Research Needs: *To analyze present policies and the instruments for their implementation on the national level. To prepare a classification of issues and policies relevant to the centrally planned economy and one relevant to the policy environment of an (albeit regulated) market economy. Such classifications would be useful for international comparative studies.*

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